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SAO Special Report No. 142

SATELLITE ORBITAL DATA

Material prepared under the supervision of I. G. Izsak
Chief, Research and Analysis Division

Smithsonian Institution
Astrophysical Observatory

Cambridge, Massachusetts 02138

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NOTE

It is in the nature of frequently used computer programs that from time to time they undergo modifications as dictated by the experience of people who use them. Thus our Differential Orbit Improvement Program, being in use since the end of 1958, has been changed on several occasions. In the past we did not give notice of any of these changes, because they affected merely the internal structure and the capabilities of the program. Some recent modifications, however, should be pointed out because they alter the definition of the mean orbital elements.

1. As before, the semimajor axis a of an orbit is being computed from the mean motion n of the satellite according to the formula

$$a = \sqrt[3]{\frac{GM}{n^2}} \left\{ 1 - \frac{J_2 a_E^2}{2p^2} \sqrt{1 - e^2} \left(1 - \frac{3}{2} \sin^2 l \right) \right\}$$

(Y. Kozai, Astron. Journ., vol. 64, pp. 367-377; in his equation (14) we put $A_2 = \frac{3}{2} J_2 a_E^2$). In the old program, the mean motion in turn was defined as the time derivative of the mean anomaly M . Therefore in cases where in addition to a polynomial part the mean anomaly also had a trigonometric part, the program produced small but unwanted, long-periodic variations in the semimajor axis. In the new program the mean motion is defined as the time derivative of the mean anomaly's polynomial part only.

2. The old program provided internally only for those first order short-periodic perturbations that are caused by the second zonal harmonic (J_2 -term) of the geopotential. The new program has the optional capability to account for lunar perturbations with periods of approximately two weeks. Their analytical expressions are quite complicated and will not be given here. As a rule, we use this feature of the program only in connection with orbits that are computed from precisely reduced Baker-Nunn observations. In our future publications of satellite orbital data we will always mention if lunar perturbations were included in the computations.

A detailed write-up of the new Differential Orbit Improvement Program, henceforth called DOI 3, will be given shortly by Mr. Edward M. Gaposhkin.

ORBITAL INFORMATION¹

The orbital elements have been derived by the indicated staff members of the Satellite Tracking Program, Smithsonian Astrophysical Observatory, employing the SAO Differential Orbit Improvement Program (DOI).

Field-reduced photographs from SAO Baker-Nunn cameras comprise the majority of observations used in computing these orbital data. SAO Moonwatch teams, the NASA Minitrack network, foreign observatories, miscellaneous U.S. and foreign observers, and various radar installations also contribute valuable observations.

As opposed to osculating elements, the elements presented here are mean elements in the sense that the effects of the short period perturbations due to the earth's oblateness have been eliminated.

SAO mean elements have been derived from observations covering several days, and are given in the form of a table. The successive sets of elements are essentially independent of each other. They are dependent, however, in the sense that high-order coefficients in the secular and the long-periodic terms are generally considered as known and as constant for periods of several weeks or months, as dictated by convenience.

The times of epoch in the mean elements are reckoned in Julian Days, but for the sake of convenience the number 2400000.5 has been subtracted to provide an abbreviated notation which we call "Modified Julian Days," or "MJD."

The units of the orbital elements are degrees for angular quantities, megameters ($Mm = 10^6$ meters) for linear quantities, and revolutions for the mean anomaly M and its derivatives.

The tabulated values of the SAO mean elements give the values of argument of perigee ω , right ascension of the ascending node Ω , inclination i , eccentricity e , and mean anomaly M as functions of time $t = T - T_0$ (where T_0 is the reference epoch) expressed in days. The single digit placed at the right of each value represents the standard error for that element and refers to the last digit given.

The same tabulation also gives the mean (anomalistic) motion n , the orbital acceleration $n'/2$ or n' (dn/dt), and the semimajor axis a or the geocentric distance of perigee q (in megameters). Of the last three columns, the one headed N indicates the number of observations used for the computation of a set of elements; the one headed D , the number of days used; and the one headed σ , the standard error of the representation of the observations relative to their assumed accuracy.

SAO smoothed elements have been derived from observations covering about two weeks or more. They are given as functions of time and generally include both secular and periodic terms. The general expression for any element E is

$$E = E_0 + E_1 t + E_2 t^2 + \dots + \sum A_i \sin(B_i + C_i t)$$

¹This work was supported in part by grant NsG 87-60 from the National Aeronautics and Space Administration.

where $t = T - T_0$ is again expressed in days. The presence of a standard error associated with a particular coefficient indicates that this quantity was determined by the process of differential orbit improvement; the absence of a standard error means that the quantity was taken from some other source.

In our computer program, the inclination and the argument of perigee are referred to the true equator of date, the right ascension of the ascending node, however, is reckoned from the mean equinox of 1950.0 along the corresponding mean equator to the intersection with the moving true equator of date, and then along the true equator of date. To transform from right ascension of the node as determined by the DOI to right ascension of the node referred to the mean equinox of date, one uses

$$\Omega^o = \Omega^o(\text{DOI}) + 3^\circ 508 \times 10^{-5} (\text{MJD} - 33281) ,$$

where MJD stands for the Modified Julian Day of the date.

The mean (anomalistic) motion n can be obtained from the smoothed elements by differentiating the expression for M , and the orbital acceleration n' can be obtained by twice differentiating the same expression for M .

The sun-perigee data are related to the perturbing effects of atmospheric drag. From left to right, are the Modified Julian Day (MJD); the perigee height Z (in kilometers) above the International Ellipsoid of Reference; the geocentric latitude of the perigee (φ); the angular geocentric distance (ψ) from the perigee of the sun; and the difference in right ascension (D.R.A.) between the perigee and the sun; all these angles are expressed in degrees. In the last column we give the rate of change of the period (P) expressed in days per day.

Satellite 1958 Alpha (Explorer I)

Beatrice Miller

I. SAO smoothed elements

The following elements are based on 50 observations and are valid for the period January 1 through January 16, 1963.

$$T_o = 38038.0 \text{ MJD}$$

$$\omega = (304^\circ 8 \pm 1) + (7^\circ 65 \pm 2)t - .001296t^2 + .3144 \cos \omega$$

$$\Omega = (59^\circ 788 \pm 7) - (5^\circ 079 \pm 1)t - .62 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 207 \pm 1) - .000340t + .40 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08989 \pm 3) + .5812 \times 10^{-4}t - .1692 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.6669 \pm 3) + (13.66979 \pm 5)t + (.0001168 \pm 7)t^2 + (.81 \pm 6) \times 10^{-6}t^3 \\ + (.18 \pm 1) \times 10^{-6}t^4 - .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.43.$

The following elements are based on 38 observations and are valid for the period January 16 through February 1, 1963.

$$T_o = 38054.0 \text{ MJD}$$

$$\omega = (66^\circ 49 \pm 1) + (7^\circ 568 \pm 3)t - .001296t^2 + .3144 \cos \omega$$

$$\Omega = (338^\circ 569 \pm 5) - (5^\circ 0775 \pm 8)t - .62 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 205 \pm 1) - .000212t + .40 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08999 \pm 2) + .397 \times 10^{-5}t - .1692 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.41927 \pm 3) + (13.673959 \pm 6)t + (.822 \pm 6) \times 10^{-4}t^2 - (.96 \pm 4) \times 10^{-6}t^3 \\ + (.138 \pm 9) \times 10^{-6}t^4 - .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.08.$

The following elements are based on 26 observations and are valid for the period February 1 through February 15, 1963.

$$T_o = 38068.0 \text{ MJD}$$

$$\omega = (172^\circ 68 \pm 2) + (7^\circ 590 \pm 5)t - .001296t^2 + .3144 \cos \omega$$

$$\Omega = (267^\circ 470 \pm 6) - (5^\circ 080 \pm 1)t - .62 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 202 \pm 2) - .000100t + .40 \times 10^{-5}t^2 - .0039 \sin \omega$$

$$e = (.08977 \pm 2) - .4340 \times 10^{-4}t - .1692 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.87147 \pm 7) + (13.67642 \pm 1)t + (.86 \pm 1) \times 10^{-4}t^2 + (.65 \pm 8) \times 10^{-6}t^3 \\ + (.80 \pm 24) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.00$.

The following elements are based on 49 observations and are valid for the period February 15 through March 1, 1963.

$$T_o = 38082.0 \text{ MJD}$$

$$\omega = (278^\circ 91 \pm 1) + (7^\circ 580 \pm 3)t - .00094t^2 + .3144 \cos \omega$$

$$\Omega = (196^\circ 333 \pm 4) - (5^\circ 081 \pm 1)t - .56 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 200 \pm 1) + .954 \times 10^{-4}t + .37 \times 10^{-6}t^2 - .0039 \sin \omega$$

$$e = (.08975 \pm 2) + .6654 \times 10^{-4}t - .1660 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.35782 \pm 3) + (13.678611 \pm 9)t + (.658 \pm 4) \times 10^{-4}t^2 - (.46 \pm 6) \\ \times 10^{-6}t^3 - .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.43$.

The following elements are based on 47 observations and are valid for the period March 1 through March 16, 1963.

$$T_o = 38096.0 \text{ MJD}$$

$$\omega = (25^\circ 05 \pm 2) + (7^\circ 572 \pm 5)t - .00094t^2 + .3144 \cos \omega$$

$$\Omega = (125^\circ 193 \pm 5) - (5^\circ 083 \pm 1)t - .56 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 205 \pm 1) + .0001057t + .37 \times 10^{-6}t^2 - .0039 \sin \omega$$

$$e = (.08980 \pm 2) + .2006 \times 10^{-4}t - .1660 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.87054 \pm 7) + (13.68045 \pm 1)t + (.929 \pm 7) \times 10^{-4}t^2 (.31 \pm 1) \times 10^{-5}t^3 \\ + (.38 \pm 26) \times 10^{-7}t^4 - .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.23$.

The following elements are based on 71 observations and are valid for the period March 16 through April 1, 1963.

$$T_o = 38112.0 \text{ MJD}$$

$$\omega = (146^\circ 61 \pm 2) + (7^\circ 579 \pm 3)t - .000094t^2 + .3144 \cos \omega$$

$$\Omega = (43^\circ 862 \pm 4) - (5^\circ 0845 \pm 7)t - .56 \times 10^{-4}t^2 + .0031 \cos \omega$$

$$i = (33^\circ 205 \pm 1) + .0001176t + .37 \times 10^{-6}t^2 - .0039 \sin \omega$$

$$e = (.089714 \pm 9) - .3306 \times 10^{-4}t - .1160 \times 10^{-5}t^2 + .0004980 \sin \omega$$

$$M = (.77854 \pm 4) + (13.682900 \pm 8)t + (.714 \pm 2) \times 10^{-4}t^2 - (.29 \pm 4) \times 10^{-6}t^3$$

$$- .0008998 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.15$.

II. SAO mean elements - Satellite 1958 Alpha

3 January - 28 March 1963

T (MJD)	w	Ω	1	e	M	n	n'/2	q	N	D	σ
38032.0	260.0 4	90.21 1	33.210 3	.08957 7	.649 1	13.668494 3	.124E-3 2	6.725778	28	8	.85
38036.0	289.9 1	69.94 1	33.209 2	.08951 5	.3263 4	13.669469 3	.1194E-3 9	6.725865	28	8	.43
38040.0	320.7 2	49.63 1	33.208 3	.0899 1	.0048 6	13.670445 2	.127E-3 1	6.722527	27	8	.67
38044.0	351.014 9	29.314 3	33.215 2	.09003 3	.68915 2	13.671602 3	.162E-3 2	6.721356	24	8	.47
38048.0	21.33 2	9.018 5	33.202 5	.09027 4	.37805 4	13.672755 4	.129E-3 2	6.719219	23	8	.97
38052.0	51.53 2	348.72 1	33.201 4	.09042 4	.07115 5	13.673616 2	.94E-4 1	6.717822	17	8	.94
38056.0	81.69 2	328.411 6	33.200 1	.09047 2	.76734 3	13.674297 1	.760E-4 6	6.717211	17	8	.58
38060.0	111.97 6	308.10 2	33.200 4	.09025 6	.4656 2	13.675017 7	.113E-3 3	6.718586	18	8	2.68
38064.0	141.97 3	287.78 1	33.202 3	.09019 4	.16803 8	13.675907 3	.98E-4 1	6.718775	20	8	1.42
38068.0	172.29 4	267.47 1	33.203 3	.08985 4	.8725 1	13.676598 5	.90E-4 2	6.721075	15	8	1.15
38072.0	202.8 1	247.14 2	33.211 5	.087 3	.5799 5	13.676983 4	.100E-3 2	6.741828	10	8	.80
38076.0	233.13 4	226.823 7	33.207 3	.08911 5	.2892 1	13.677683 4	.81E-4 2	6.726163	12	8	.99
38080.0	263.59 2	206.497 7	33.203 2	.08924 3	.00123 5	13.678294 2	.59E-4 1	6.725055	22	8	.81
38084.0	294.19 1	186.170 4	33.203 1	.08947 2	.71494 4	13.678782 2	.595E-4 7	6.723141	35	8	.56
38088.0	324.68 2	165.847 5	33.204 1	.08929 2	.43095 5	13.679279 2	.682E-4 7	6.724303	41	8	.90
38092.0	355.09 2	145.526 6	33.203 1	.08966 2	.14906 5	13.679821 2	.672E-4 9	6.721407	40	8	1.01
38096.0	25.37 6	125.19 2	33.205 4	.08994 6	.8697 1	13.680449 3	.96E-4 2	6.719085	27	8	1.98
38100.0	55.8 2	104.85 2	33.206 4	.0894 8	.5931 3	13.681293 5	.111E-3 2	6.722891	13	8	.76
38104.0	85.81 3	84.531 5	33.202 2	.08996 6	.32006 9	13.681856 6	.64E-4 1	6.718475	12	8	.66
38108.0	116.04 3	64.217 9	33.209 4	.09009 3	.04866 7	13.682394 3	.73E-4 1	6.717384	15	8	.68
38112.0	146.33 2	43.865 5	33.202 2	.08994 1	.77930 5	13.682958 1	.728E-4 5	6.718294	28	8	.68
38116.0	176.60 2	23.520 4	33.205 1	.089592 9	.51214 4	13.683519 1	.664E-4 5	6.720676	53	8	.84

Table 1

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1958 ALPHA

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38032.	354.	-32.6	57.8	65.4	-0.133E-05
38036.	353.	-31.0	67.1	76.0	-0.128E-05
38040.	347.	-20.3	76.8	83.5	-0.136E-05
38044.	343.	-4.9	84.3	85.8	-0.173E-05
38048.	342.	11.5	91.1	86.8	-0.138E-05
38052.	343.	25.4	98.9	90.7	-0.101E-05
38056.	345.	32.8	108.0	99.8	-0.813E-06
PERIGEE IN EARTH SHADOW					
38060.	346.	30.5	116.6	111.0	-0.121E-05
38064.	343.	19.7	121.0	117.7	-0.105E-05
38068.	343	4.2	120.1	120.1	-0.962E-06
38072.	364.	-12.3	116.5	121.6	-0.107E-05
38076.	352.	-26.0	114.9	126.1	-0.866E-06
38080.	353.	-33.0	119.2	136.1	-0.631E-06
38084.	350.	-30.0	129.6	147.9	-0.636E-06
38088.	348.	-18.5	143.5	154.9	-0.729E-06
38092.	343.	-2.7	155.5	157.4	-0.718E-06
38096.	342.	13.6	157.7	159.1	-0.103E-05
38100.	349.	26.9	152.3	164.3	-0.119E-05
38104.	346.	33.1	148.6	174.4	-0.684E-06
38108.	344.	29.5	150.5	185.7	-0.780E-06
38112.	342.	17.7	157.7	192.3	-0.778E-06
38116.	342.	1.9	164.7	194.6	-0.709E-06

Satellite 1959 Alpha 1 (Vanguard II)

Maria Gutierrez

I. SAO smoothed elements

The following elements are based on 133 observations and are valid for the period January 1 through February 1, 1963.

$$T_0 = 38046.0 \text{ MJD}$$

$$\omega = (126^\circ 705 \pm 5) + (5^\circ 2901 \pm 4)t - 59 \times 10^{-4}t^2 + .1523 \cos \omega$$

$$\Omega = (199^\circ 569 \pm 2) - (3^\circ 5203 \pm 1)t - 42 \times 10^{-5}t^2 + .0077 \cos \omega$$

$$i = (32^\circ 8762 \pm 9) - .0069 \sin \omega$$

$$e = (.16411 \pm 1) - .138 \times 10^{-5}t + .000457 \sin \omega$$

$$M = (.49548 \pm 2) + (11.478563 \pm 1)t + (.295 \pm 3) \times 10^{-5}t^2 + (.63 \pm 26) \\ \times 10^{-8}t^3 - .000439 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.10$.

The following elements are based on 152 observations and are valid for the period February 1 through March 1, 1963.

$$T_0 = 38074.0 \text{ MJD}$$

$$\omega = (274^\circ 891 \pm 4) + (5^\circ 2895 \pm 4)t - 59 \times 10^{-4}t^2 + .1523 \cos \omega$$

$$\Omega = (101^\circ 017 \pm 2) - (3^\circ 5194 \pm 2)t - 42 \times 10^{-5}t^2 + .0077 \cos \omega$$

$$i = (32^\circ 8800 \pm 8) - .0069 \sin \omega$$

$$e = (.16416 \pm 1) - .138 \times 10^{-5}t + .000457 \sin \omega$$

$$M = (.89759 \pm 1) + (11.478766 \pm 1)t + (.430 \pm 3) \times 10^{-5}t^2 - (.47 \pm 40) \\ \times 10^{-8}t^3 - .000439 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.23$.

The following elements are based on 114 observations and are valid for the period March 1 through April 1, 1963.

$$T_o = 38104.0 \text{ MJD}$$

$$\omega = (73^\circ 639 \pm 4) + (5^\circ 2907 \pm 5)t - 59 \times 10^{-4}t^2 + 1523 \cos \omega$$

$$\Omega = (355^\circ 425 \pm 2) - (3^\circ 5199 \pm 3)t - 42 \times 10^{-5}t^2 + 0077 \cos \omega$$

$$i = (32^\circ 8820 \pm 6) - 0069 \sin \omega$$

$$e = (.16428 \pm 2) - .138 \times 10^{-5}t + .000457 \sin \omega$$

$$M = (.244266 \pm 7) + (11.4790353 \pm 8)t + (.466 \pm 2) \times 10^{-5}t^2 - (.31 \pm 2) \times 10^{-7}t^3 \\ - .000439 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.33$.

T (MJD)	ω	Ω	ι	e	M	n	n'/2	q	N	D	σ
38020.0	42.173 7	255.895 3	32.871 1	*16439 2	*83888 2	11.478477 6	*32E-5 4	6.935410	58	8	.38
38034.0	63.280 8	241.819 4	32.869 2	*16453 2	*75294 3	11.478518 8	*39E-5 6	6.934264	44	8	.41
38038.0	84.38 2	227.73 1	32.873 5	*16460 5	*66718 6	11.47855 2	*3E-5 1	6.933678	43	8	.43
38042.0	105.62 8	213.60 3	32.880 1	*1643 3	*5811 2	11.47779 3	-.26E-4 6	6.936778	5	8	.40
38046.0	126.6 1	199.62 5	32.887 2	*1643 2	*4954 5	11.4790 3	-.5E-4 2	6.935896	15	8	1.80
38050.0	147.72 2	185.472 7	32.863 4	*16436 3	*41024 6	11.47859 1	*2E-5 1	6.935668	28	8	.42
38054.0	168.86 1	171.395 3	32.8874 2	*16420 2	*32467 3	11.47861 1	*12E-5 7	6.936963	41	8	.36
38058.0	190.05 1	157.319 2	32.879 1	*16405 2	*23902 5	11.47861 1	*46E-5 6	6.938226	56	8	.37
38062.0	211.27 1	143.244 3	32.8810 9	*16389 2	*15343 3	11.47853 8	*48E-5 5	6.939479	66	8	.40
38066.0	232.463 8	129.164 4	32.8839 9	*16376 2	*06807 3	11.47806 5	*40E-5 5	6.940592	53	8	.41
38070.0	253.685 7	115.085 6	32.888 1	*16375 2	*98274 2	11.478730 5	*45E-5 5	6.940659	34	8	.39
38074.0	274.901 7	101.006 6	32.890 2	*16374 2	*89758 2	11.47878 1	*62E-5 9	6.940696	28	8	.30
38078.0	296.12 2	86.946 7	32.888 3	*16378 6	*81248 4	11.478796 7	*43E-5 7	6.940336	37	8	.49
38082.0	317.320 8	72.871 3	32.885 2	*16389 4	*72764 2	11.478839 5	*25E-5 6	6.939430	46	8	.52
38086.0	338.519 6	58.790 3	32.886 3	*16407 3	*64291 2	11.478853 5	*48E-5 7	6.937956	42	8	.52
38090.0	359.71 1	44.6719 7	32.888 3	*16422 3	*58033 2	11.478870 9	*58E-5 4	6.936704	34	8	.51
38094.0	20.85 2	30.65 1	32.886 3	*16441 4	*47400 2	11.478935 9	*54E-5 4	6.935104	25	8	.55
38098.0	42.007 9	16.558 7	32.878 1	*16459 3	*38989 1	11.478981 6	*51E-5 4	6.933559	24	8	.43
38102.0	63.122 8	2.475 6	32.8760 9	*16466 3	*30602 1	11.479025 6	*45E-5 4	6.932941	24	8	.46
38106.0	84.225 9	348.391 6	32.875 2	*16478 4	*22232 1	11.479052 6	*43E-5 5	6.931950	27	8	.61
38110.0	105.327 7	334.311 5	32.875 1	*16478 3	*13877 1	11.479045	*38E-5 5	6.931919	37	8	.55
38114.0	126.44 1	320.219 8	32.874 1	*16471 3	*05532 3	11.479121	*44E-5 9	6.932490	35	8	.51
38118.0	147.566 8	306.144 6	32.873 2	*16455 3	*97195 1	11.479162	*26E-5 8	6.933805	29	8	.41

Table 2

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1959 ALPHA 1

MJD	Z	Ψ	ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38030.	560.	21.4	46.1	12.4	-0.486E-07
38034.	561.	29.0	53.9	15.8	-0.592E-07
38038.	562.	32.7	58.7	21.5	-0.455E-07
38042.	564.	31.4	59.5	28.1	0.395E-06
38046.	562.	25.8	56.6	32.9	0.759E-06
38050.	559.	16.8	50.5	35.1	-0.304E-07
38054.	559.	6.0	43.0	35.4	-0.182E-07
38058.	560.	-5.4	36.4	35.0	-0.698E-07
38062.	563.	-16.4	33.8	35.4	-0.729E-07
38066.	566.	-25.5	36.5	37.8	-0.607E-07
38070.	568.	-31.4	42.6	42.9	-0.683E-07
38074.	569.	-32.8	49.4	50.0	-0.941E-07
38078.	567.	-29.2	55.0	56.5	-0.653E-07
38082.	564.	-21.6	58.8	60.5	-0.379E-07
38086.	560.	-11.5	61.0	62.1	-0.729E-07
38090.	558.	-0.2	62.5	62.3	-0.880E-07
38094.	558.	11.1	64.5	62.5	-0.820E-07
38098.	558.	21.3	67.8	64.0	-0.774E-07
38102.	560.	29.0	72.4	68.1	-0.683E-07
38106.	560.	32.7	77.8	74.6	-0.653E-07
38110.	559.	31.6	82.9	81.8	-0.577E-07
38114.	558.	25.9	86.8	87.3	-0.668E-07
38118.	557.	16.9	89.2	90.2	-0.395E-07

Satellite 1959 Eta (Vanguard III)

Phyllis Stern

I. SAO smoothed elements

The following elements are based on 95 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38046.0 \text{ MJD}$$

$$\omega = (318.833 \pm 5) + (4.8938 \pm 4)t - .23 \times 10^{-4}t^2 + .1295 \cos \omega$$

$$\Omega = (199.705 \pm 2) - (3.2878 \pm 2)t + .28 \times 10^{-5}t^2 + .0090 \cos \omega$$

$$i = (33.3545 \pm 6) + .871 \times 10^{-4}t - .0077 \sin \omega$$

$$e = (.188786 \pm 7) - .65 \times 10^{-6}t + .000452 \sin \omega$$

$$M = (.866437 \pm 9) + (11.0884868 \pm 8)t + (.90 \pm 2) \times 10^{-6}t^2 + (.46 \pm 17) \\ \times 10^{-8}t^3 - .000376 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.33$.

The following elements are based on 82 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38075.0 \text{ MJD}$$

$$\omega = (100.761 \pm 5) + (4.8918 \pm 4)t - .23 \times 10^{-4}t^2 + .1295 \cos \omega$$

$$\Omega = (104.371 \pm 2) - (3.2870 \pm 2)t + .28 \times 10^{-5}t^2 + .0090 \cos \omega$$

$$i = (33.3580 \pm 6) + .871 \times 10^{-4}t - .0077 \sin \omega$$

$$e = (.18877 \pm 1) - .65 \times 10^{-6}t + .000452 \sin \omega$$

$$M = (.43296 \pm 1) + (11.0885119 \pm 9)t + (.82 \pm 2) \times 10^{-6}t^2 + (.28 \pm 3) \times 10^{-7}t^3 \\ - .000376 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.35$.

The following elements are based on 68 observations and are valid for the period March 1 through April 1, 1963.

$$T_0 = 38105.0 \text{ MJD}$$

$$\omega = (247^\circ 560 \pm 3) + (4^\circ 8919 \pm 3)t - .23 \times 10^{-4}t^2 + .1295 \cos \omega$$

$$\Omega = (5^\circ 754 \pm 2) - (3^\circ 2872 \pm 3)t + .28 \times 10^{-5}t^2 + .00090 \cos \omega$$

$$i = (33^\circ 3584 \pm 6) - .871 \times 10^{-4}t - .0077 \sin \omega$$

$$e = (.18884 \pm 1) - .65 \times 10^{-6}t + .000452 \sin \omega$$

$$M = (.087976 \pm 5) + (11.0884668 \pm 8)t - (.35 \pm 2) \times 10^{-6}t^2 + (.30 \pm 3) \\ \times 10^{-7}t^3 - .000376 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.05$.

II. SAO mean elements - Satellite 1959 Eta

1 January - 30 March 1963

T (MJD)	ω	Ω	i	e	M	n	n ^{1/2}	q	N	D	σ
38030.0	240.467 8	252.306 7	33.362 1	•18839 2	•45103 1	11.088465 1	-•44E-6 67	6.893368 27	6	.54	
38034.0	260.083 7	239.160 5	33.3625 8	•18832 2	•80478 1	11.088459 1	-•31E-5 5	6.893856 22	6	.44	
38038.0	279.74 2	226.01 1	33.361 3	•18831 2	•15846 3	11.088488 4	-•17E-5 24	6.893993 12	6	.66	
38042.0	299.30 2	212.864 5	33.357 2	•18838 2	•51234 3	11.088472 2	-•14E-5 13	6.893421 11	6	.46	
38046.0	318.95 1	199.725 6	33.359 2	•18846 2	•86605 3	11.088490 2	•25E-5 11	6.892760 11	6	.34	
38050.0	338.57 2	186.54 1	33.357 2	•18857 2	•21996 3	11.088499 3	•27E-5 17	6.891846 21	6	.48	
38054.0	358.07 2	173.401 7	33.352 2	•18876 2	•57414 4	11.088497 3	-•42E-7 12	6.890172 21	6	.64	
38058.0	17.65 1	160.257 7	33.352 2	•18891 1	•92813 3	11.088507 2	•5E-6 11	6.8888910 28	6	.69	
38062.0	37.253 7	147.110 4	33.3513 8	•18900 1	•28212 2	11.088509 1	•13E-6 56	6.8888117 40	6	.44	
38066.0	56.81 1	133.956 7	33.351 1	•18915 2	•63620 2	11.088503 2	-•8E-6 10	6.886883 21	6	.49	
38070.0	76.33 2	120.81 1	33.348 3	•18923 3	•99034 4	11.088498 4	-•2E-6 24	6.886216 12	6	.63	
38074.0	95.85 2	107.65 1	33.350 3	•18925 3	•34451 3	11.088510 3	-•10E-5 14	6.886008 15	6	.60	
38078.0	115.37 3	94.505 2	33.351	•18924 5	•69868 5	11.088518 3	•19E-5 17	6.886136 10	6	.90	
38082.0	134.92 1	81.352 6	33.359 4	•18907 2	•05285 2	11.088523 5	-•19E-5 23	6.887510 11	6	.49	
38086.0	154.49 1	68.230 8	33.339 1	•18925 9	•40696 3	11.088521 6	-•52E-5 34	6.886009 18	6	.60	
38090.0	174.018 7	55.063 5	33.372 4	•18889 4	•76121 2	11.088522 5	-•50E-5 19	6.889102 15	6	.34	
38094.0	193.62 3	41.88 2	33.353 8	•1888 1	•1152 1	11.088488 1	-•13E-4 6	6.88938 8 8	6	.28	
38098.0	213.19 4	28.77 2	33.370 5	•1883 3	•46901 7	11.088468 9	-•65E-5 61	6.893875 6	6	.39	
38102.0	232.797 6	15.618 6	33.366 2	•18848 1	•82280 9	11.088468 2	•57E-6 82	6.892611 19	6	.33	
38106.0	252.407 6	2.471 4	33.368 1	•18841 2	•17655 1	11.088458 4	-•35E-5 11	6.893219 16	6	.34	
38110.0	272.02 1	349.32 1	33.367 2	•18842 2	•53028 1	11.088473 3	-•18E-5 30	6.893109 12	6	.40	
38114.0	291.63 1	336.17 1	33.365 2	•18841 2	•88405 2	11.088468 1	-•13E-5 7	6.893155 16	6	.52	
38118.0	311.22 1	323.04 1	33.363 2	•18844 2	•23781 1	11.088472 2	•16E-5 10	6.892880 14	6	.42	

Table 3

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1959 ETA

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
PERIGEE IN EARTH SHADOW					
38030.	520.	-28.6	122.0	207.4	0.716E-08
38034.	522.	-32.8	116.5	212.2	0.504E-07
38038.	522.	-32.8	114.0	218.1	0.277E-07
38042.	520.	-28.7	114.9	222.9	0.228E-07
38046.	517.	-21.2	118.8	225.5	-0.407E-07
38050.	514.	-11.6	124.8	226.0	-0.439E-07
38054.	512.	-1.1	131.3	225.2	0.683E-09
38058.	511.	9.6	136.2	224.4	-0.813E-08
38062.	512.	19.4	137.7	224.6	-0.211E-08
38066.	513.	27.4	135.1	227.0	0.130E-07
38070.	514.	32.3	130.0	231.6	0.325E-08
38074.	514.	33.2	124.1	237.8	0.163E-07
38078.	513.	29.8	119.0	243.3	-0.309E-07
38082.	512.	22.9	115.3	246.8	0.309E-07
38086.	509.	13.7	113.3	248.1	0.846E-07
38090.	511.	3.3	112.4	247.9	0.813E-07
PERIGEE IN SUNLIGHT					
38094.	512.	-7.4	111.4	247.4	0.211E-06
38098.	517.	-17.5	109.6	247.8	0.106E-06
38102.	518.	-26.0	106.5	250.1	-0.927E-08
38106.	521.	-31.6	102.3	254.7	0.569E-07
38110.	521.	-33.3	97.5	261.1	0.293E-07
38114.	520.	-30.7	93.2	267.3	0.211E-07
38118.	518.	-24.4	90.0	271.5	-0.260E-07

Satellite 1959 Iota 1 (Explorer VII)

Phyllis Stern

I. SAO smoothed elements

The following elements are based on 127 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38046.0 \text{ MJD}$$

$$\omega = (147^\circ 92 \pm 2) + (3^\circ 399 \pm 2)t + .000118t^2 + 1.2206 \cos \omega$$

$$\Omega = (200^\circ 784 \pm 1) + (-4^\circ 1913 \pm 2)t + .17 \times 10^{-5}t^2 + .0054 \cos \omega$$

$$i = (50^\circ 3060 \pm 9) - .0014 \sin \omega$$

$$e = (.036211 \pm 9) + (.35 \pm 9) \times 10^{-5}t + .000790 \sin \omega$$

$$M = (.67674 \pm 5) + (14.234297 \pm 5)t + (.142 \pm 2) \times 10^{-5}t^2 + (.30 \pm 4) \times 10^{-7}t^3 \\ - .003059 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.48$.

The following elements are based on 135 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38075.0 \text{ MJD}$$

$$\omega = (246^\circ 78 \pm 2) + (3^\circ 417 \pm 3)t + .000118t^2 + 1^\circ 2206 \cos \omega$$

$$\Omega = (79^\circ 240 \pm 1) - (4^\circ 1906 \pm 2)t + .17 \times 10^{-5}t^2 + .0054 \cos \omega$$

$$i = (50^\circ 311 \pm 1) - .0014 \sin \omega$$

$$e = (.036194 \pm 6) - (.83 \pm 94) \times 10^{-6}t + .000790 \sin \omega$$

$$M = (.47259 \pm 7) + (14.234382 \pm 7)t + (.224 \pm 3) \times 10^{-5}t^2 + (.48 \pm 4) \\ \times 10^{-7}t^3 - .003059 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.60$.

The following elements are based on 115 observations and are valid for the period March 1 through April 1, 1963.

$$T_o = 38105.0 \text{ MJD}$$

$$\omega = (349^{\circ}00' \pm 2) + (3^{\circ}413 \pm 2)t + .000118t^2 + 1^{\circ}2206 \cos \omega$$

$$\Omega = (313^{\circ}514 \pm 1) - (4^{\circ}1912 \pm 2)t + .17 \times 10^{-5}t^2 + .0054 \cos \omega$$

$$i = (50^{\circ}3075 \pm 9) - .0014 \sin \omega$$

$$e = (.03614 \pm 1) + (.54 \pm 13) \times 10^{-5}t + .000790 \sin \omega$$

$$M = (.50718 \pm 5) + (14.234572 \pm 6)t + (.222 \pm 3) \times 10^{-5}t^2 - (.146 \pm 4) \times 10^{-6}t^3 \\ - .003059 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.53.$

T (MJD)	ω	Ω	i	e	M	n	n'/2	q	W	D	σ
38030.0	93.33 2	267.825 5	50.299 3	.03706 3	.92899 7	14.234163 1	.53E-5 6	6.925181	26	8	.48
38034.0	106.69 2	251.076 3	50.304 2	.03697 2	.86649 6	14.234198 2	.40E-5 9	6.925845	36	8	.60
38038.0	120.05 2	234.313 2	50.302 2	.03686 2	.80416 5	14.234221 1	.22E-5 5	6.926600	29	8	.40
38042.0	133.40 2	217.547 1	50.304 1	.03679 2	.74193 5	14.234232 1	.68E-6 34	6.927123	22	8	.29
38046.0	146.92 3	200.782 2	50.305 2	.03662 1	.67925 9	14.234224 1	-.56E-6 62	6.928313	30	8	.41
38050.0	160.46 3	184.014 2	50.306 2	.03642 1	.6166 1	14.234231 2	.20E-5 5	6.929760	40	8	.45
38054.0	173.89 4	167.247 2	50.307 2	.03626 1	.5543 1	14.234253 1	.39E-5 4	6.930893	35	8	.47
38058.0	187.55 4	150.483 3	50.307 1	.03607 1	.4915 1	14.234285 1	.38E-5 5	6.932224	29	8	.41
38062.0	201.26 3	133.724 3	50.307 2	.035880 9	.42869 9	14.234317 1	.30E-5 5	6.933607	39	8	.38
38066.0	215.09 4	116.961 4	50.307 3	.03571 2	.3657 1	14.234321 1	-.97E-6 57	6.934806	32	8	.47
38070.0	229.06 9	100.119 1	50.311 8	.03561 3	.3023 3	14.234328 4	-.30E-5 12	6.935563	15	8	.85
38074.0	242.83 6	83.423 3	50.314 3	.03546 1	.2396 2	14.234338 2	.26E-5 6	6.936623	27	8	.55
38078.0	256.80 4	66.666 1	50.312 1	.035369 7	.1763 1	14.234363 1	.40E-5 4	6.937122	56	8	.55
38082.0	270.74 4	49.907 1	50.313 1	.035367 8	.1133 1	14.234390 1	.25E-5 4	6.937269	55	8	.51
38086.0	284.54 4	33.145 3	50.314 3	.03542 1	.0508 1	14.234401 1	.78E-6 45	6.936925	34	8	.50
38090.0	298.49 3	16.368 3	50.303 3	.03547 1	.98790 8	14.234397 1	-.15E-5 5	6.936528	28	8	.51
38094.0	312.38 3	359.608 4	50.305 3	.03559 2	.92510 9	14.234399 2	.27E-5 6	6.935651	17	8	.42
38098.0	326.18 9	342.853 7	50.311 3	.03580 4	.8626 2	14.234432 3	.71E-5 11	6.934126	15	8	.63
38102.0	339.09 6	326.09 1	50.315 7	.03555 2	.803 2	14.234485 2	.46E-5 7	6.935978	32	8	.50
38106.0	353.71 3	309.328 2	50.313 2	.03607 2	.73847 8	14.234513 1	-.16E-6 37	6.932212	35	8	.34
38110.0	7.24 2	292.563 1	50.306 2	.03630 2	.67714 6	14.234513 2	.13E-6 61	6.930545	43	8	.51
38114.0	20.89 2	275.798 1	50.304 1	.03644 2	.61547 5	14.234504 1	-.41E-5 5	6.929511	42	8	.53
38118.0	34.42 2	259.032 3	50.305 2	.03664 3	.55405 7	14.234489 2	-.75E-6 93	6.928115	27	8	.56

Table 4

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1959 IOTA 1

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38030.	559.	50.2	102.8	82.3	-0.523E-07
38034.	559.	47.5	100.8	81.1	-0.395E-07
38038.	558.	41.8	95.5	77.0	-0.217E-07
38042.	555.	34.0	86.5	69.7	-0.671E-08
38046.	554.	24.8	74.1	60.0	0.553E-08
38050.	553.	14.9	59.4	48.8	-0.197E-07
38054.	553.	4.7	43.3	36.7	-0.385E-07
38058.	554.	-5.8	26.9	24.5	-0.375E-07
38062.	557.	-16.2	12.3	12.8	-0.296E-07
38066.	561.	-26.3	10.6	2.2	0.957E-08
38070.	564.	-35.5	21.7	353.6	0.296E-07
38074.	568.	-43.2	31.7	347.8	-0.257E-07
38078.	571.	-48.5	38.4	345.7	-0.395E-07
38082.	572.	-50.3	41.3	346.4	-0.247E-07
38086.	570.	-48.2	40.6	346.8	-0.770E-08
38090.	568.	-42.6	37.6	344.5	0.148E-07
38094.	564.	-34.6	34.7	338.7	-0.267E-07
38098.	560.	-25.4	35.5	330.1	-0.701E-07
38102.	559.	-15.9	42.3	319.1	-0.454E-07
38106.	554.	-4.8	51.7	308.3	0.158E-08
38110.	552.	5.6	63.5	296.6	-0.128E-08
38114.	553.	15.9	74.8	285.3	0.405E-07
38118.	554.	25.8	84.2	274.8	0.740E-08

T (MJD)	w	Q	i	e	M	n	n'/2	q	N	D	σ
38030.0	253.7 3	346.4 1 2	47.230 9	•0460 1	•295 1	12.464270 6	-•9E-4 1	7.495491	25	2	•31
38031.0	257.62 7	343.148 5	47.241 4	•04524 5	•7590 2	12.46411 1	-•11E-3 2	7.501779	21	2	•42
38032.0	261.24 4	339.988 3	47.246 2	•04468 2	•2236 1	12.463983 7	-•3E-4 2	7.506250	23	2	•27
38033.0	265.12 5	336.628 5	47.253 4	•04437 3	•6873 1	12.46388 1	-•6E-4 3	7.508678	31	2	•51
38034.0	269.11 6	333.388 7	47.264 4	•04387 4	•1506 2	12.463758 9	-•11E-3 2	7.512691	23	2	•51
38035.0	272.99 8	330.084 8	47.249 4	•04321 5	•6142 2	12.46369 1	-•13E-3 2	7.517897	22	2	•52
38036.0	277.16 7	326.801 7	47.239 4	•04275 4	•0769 2	12.46353 1	-•6E-4 2	7.521548	23	2	•40
38037.0	281.05 7	323.543 5	47.243 3	•04221 4	•5402 2	12.46342 1	-•11E-3 4	7.525863	18	2	•30
* 38038.0	285.5 1	320.266 7	47.230 5	•04155 6	•0019 3	12.463378 9	-•4E-4 2	7.531080	18	2	•49
38039.0	289.27 8	316.997 6	47.240 4	•04117 4	•4653 2	12.46329 1	-•1E-4 2	7.534081	23	2	•48
38040.0	293.27 6	313.728 5	47.242 3	•04075 3	•9281 2	12.463252 8	-•5E-4 2	7.537391	25	2	•57
38041.0	297.3 1	310.458 9	47.247 4	•04032 6	•3907 3	12.46315 1	-•5E-4 2	7.540780	17	2	•64
38042.0	302.2 2	307.18 1	47.229 4	•03963 5	•8507 5	12.46307 2	•8E-4 5	7.546278	18	2	•54
38043.0	306.07 9	303.894 5	47.232 3	•03928 3	•3138 3	12.463107 9	•1E-4 2	7.549011	27	2	•48
38044.0	309.87 6	300.622 4	47.239 2	•03896 2	•7770 2	12.463051 9	-•2E-4 1	7.551529	31	2	•43
38045.0	313.88 7	297.358 5	47.246 3	•03862 3	•2395 2	12.463027 9	-•2E-4 2	7.554237	26	2	•48
38046.0	318.28 7	294.084 5	47.248 3	•03822 3	•7009 2	12.463008 9	-•4E-4 2	7.557382	29	2	•58
38047.0	322.25 7	290.812 5	47.249 2	•03792 3	•1635 2	12.462995 1	-•1E-4 2	7.559793	32	2	•62
38048.0	326.31 7	287.549 4	47.254 2	•03763 2	•6258 2	12.462917 7	-•3E-4 1	7.562046	25	2	•45
38049.0	330.83 9	284.270 5	47.255 2	•03728 3	•0868 3	12.462919 8	•2E-6 2	7.564812	29	2	•62
38050.0	335.03 8	281.007 4	47.262 2	•03699 2	•5486 2	12.462884 8	•1E-4 2	7.567103	32	2	•59
38051.0	339.41 7	277.737 3	47.262 2	•03664 2	•0100 2	12.462891 6	-•1E-5 1	7.569825	33	2	•37
38052.0	343.6 1	274.453 5	47.273 3	•03642 3	•4718 3	12.46286 1	-•1E-4 2	7.571553	34	2	•71
38053.0	347.7 1	271.195 7	47.277 4	•03621 4	•9340 3	12.46282 1	-•3E-4 3	7.573228	26	2	•90
38054.0	351.76 7	267.934 4	47.278 3	•03610 2	•3961 2	12.462903 7	-•5E-4 2	7.574074	28	2	•54
38055.0	355.6 1	264.672 4	47.279 3	•03582 2	•8590 3	12.462882 7	•1E-4 2	7.576282	24	2	•53
38056.0	359.8 5	261.41 1	47.284 9	•0356 2	•321 1	12.462901 8	•1E-4 2	7.578085	19	2	•34
38057.0	4.31 9	258.149 3	47.281 2	•03546 2	•7818 3	12.462903 8	-•2E-4 2	7.579130	25	2	•37
38058.0	8.47 8	254.879 3	47.289 4	•03536 3	•2438 2	12.463013 8	•2E-4 2	7.579859	28	2	•48
38059.0	12.57 8	251.615 4	47.291 5	•03509 4	•7061 3	12.46312 2	•5E-4 2	7.581928	23	2	•67
38060.0	16.62 8	248.350 3	47.290 4	•03483 3	•1687 2	12.463365 8	•12E-3 1	7.583894	20	2	•43

T (MD)	w	Ω	1	e	M	n	$n'/2$	q	N	D	σ
38061.0	20.61 6	245.083 3	47.285 3	.03469 3	.6318 2	12.46353 1	.7E-4 1	7.584905	26 2	.49	
38062.0	24.028 6	241.819 4	47.281 3	.03444 3	.0959 2	12.463730 8	.11E-3 1	7.586797	25 2	.54	
38063.0	28.040 5	238.548 3	47.278 2	.03417 2	.5590 2	12.46382 2	.1E-4 2	7.588858	16 2	.41	
38064.0	32.013 5	235.273 3	47.275 2	.03403 4	.0233 1	12.463980 7	.7E-4 1	7.589905	16 2	.33	
38065.0	35.000 6	232.007 3	47.271 2	.03367 3	.4879 2	12.464140 6	.82E-4 9	7.592641	24 2	.35	
38066.0	39.57 6	228.743 4	47.269 2	.03327 3	.9524 2	12.464306 7	.9E-4 1	7.595716	26 2	.47	
38067.0	43.21 7	225.472 5	47.269 3	.03292 5	.4175 2	12.464486 9	.9E-4 2	7.598384	17 2	.52	
38068.0	46.8 1	222.215 9	47.270 5	.0326 1	.8829 3	12.464644 2	.8E-4 3	7.601084	12 2	.76	
38069.0	50.05 7	218.924 9	47.266 5	.03212 7	.3494 2	12.46479 1	.9E-4 2	7.604614	16 2	.76	
38070.0	53.88 7	215.663 9	47.266 5	.03148 7	.8143 2	12.46496 1	.11E-3 2	7.609533	16 2	.78	
38071.0	57.02 9	212.401 7	47.268 4	.03104 6	.2815 3	12.46509 7	.14E-3 9	7.612970	14 2	.62	
38072.0	60.45 7	209.121 6	47.273 5	.03062 8	.7481 2	12.46536 1	.8E-4 2	7.616154	24 2	1.08	
38073.0	63.85 4	205.862 3	47.259 3	.02964 5	.2147 1	12.465452 8	-.7E-4 2	7.623764	28 2	.67	
38074.0	67.32 7	202.598 7	47.259 6	.02920 9	.6812 2	12.46541 1	.1E-4 3	7.627289	24 2	1.16	
38075.0	70.50 6	199.322 5	47.250 5	.02854 8	.1485 2	12.46531 2	.3E-4 2	7.632478	18 2	.73	
38076.0	73.85 7	196.060 7	47.252 7	.0280 1	.6153 2	12.46527 1	-.2E-4 2	7.636446	23 2	1.11	
38077.0	77.07 8	192.798 8	47.240 7	.0271 1	.0822 2	12.46515 2	-.2E-4 3	7.644216	24 2	1.26	
38078.0	80.18 5	189.536 5	47.239 4	.02654 7	.5494 2	12.465082 8	-.8E-4 2	7.648268	23 2	.72	
38079.0	83.65 6	186.268 7	47.232 5	.02579 8	.0154 2	12.46496 1	-.7E-4 2	7.654241	23 2	.87	
38080.0	87.05 6	183.002 8	47.227 5	.02501 8	.4816 2	12.46480 1	.3E-4 2	7.660440	24 2	.85	
38081.0	90.38 6	179.734 8	47.226 4	.02429 8	.9479 2	12.46474 1	-.1E-4 2	7.666160	32 2	.96	
38082.0	93.87 5	176.463 6	47.221 3	.02360 7	.4137 2	12.46465 1	-.6E-4 2	7.671600	26 2	.79	
38083.0	97.31 7	173.196 8	47.214 3	.02293 9	.8795 2	12.46459 1	-.8E-5 2	7.676844	17 2	.85	
38084.0	100.66 8	169.930 8	47.210 3	.02210 9	.3455 2	12.46453 1	-.4E-4 2	7.683380	15 2	.77	
38085.0	104.08 5	166.652 5	47.209 2	.02114 5	.8112 1	12.46442 1	.3E-4 2	7.691013	15 2	.47	
38086.0	107.81 6	163.368 7	47.215 2	.02020 6	.2761 2	12.464399 8	-.9E-4 2	7.698392	23 2	.58	
38087.0	111.39 4	160.130 4	47.207 1	.01972 4	.7413 1	12.464350 5	.1E-4 1	7.702149	23 2	.40	
38088.0	114.97 7	156.858 6	47.204 3	.01885 5	.2064 2	12.46431 1	-.5E-4 2	7.709074	21 2	.66	

T (MJD)	ω	Ω	i	e	M	n	$n^{1/2}$	q	M	D	σ
38089.0	118.71 8	153.593 6	47.202 3	.01812 6	.6711 2	12.46423 1	.1E-4 2	7.714782	21 2	.67	
38090.0	122.64 6	150.319 4	47.205 2	.01729 5	.1352 2	12.464193 9	-.2E-4 1	7.721383	24 2	.55	
38091.0	126.57 7	147.056 5	47.203 2	.01661 5	.5993 2	12.464176 7	.1E-4 1	7.726694	21 2	.53	
38092.0	130.72 7	143.789 4	47.209 2	.01569 4	.0628 2	12.464152 6	-.2E-4 1	7.733917	19 2	.42	
38093.0	134.73 8	140.520 5	47.214 3	.01500 5	.5266 2	12.464112 8	-.4E-4 1	7.739386	27 2	.57	
38094.0	138.8 1	137.250 6	47.217 4	.01436 7	.9901 3	12.46409 1	.4E-4 2	7.744392	24 2	.62	
38095.0	143.3 2	133.979 9	47.227 7	.01356 8	.4525 5	12.46407 1	-.1E-4 3	7.750712	18 2	.87	
38096.0	148.0 1	130.732 6	47.223 4	.01277 5	.9143 3	12.464040 9	.1E-4 2	7.756889	16 2	.42	
38097.0	152.3 3	127.47 1	47.215 7	.0123 1	.3774 8	12.46408 2	.3E-4 3	7.760944	20 2	.90	
38098.0	157.4 3	124.20 1	47.226 7	.0115 1	.8382 7	12.46412 2	.3E-4 4	7.766979	12 2	.79	
38099.0	162.6 4	120.94 1	47.23 1	.0109 1	.299 1	12.46410 2	-.5E-4 3	7.771937	10 2	.78	
38100.0	168.2 4	117.68 1	47.238 8	.01014 7	.758 1	12.46413 1	-.9E-4 2	7.777521	14 2	.63	
38101.0	174.4 3	114.437 7	47.252 6	.00943 7	.216 1	12.46408 1	.6E-4 2	7.783174	24 2	.70	
38102.0	178.4 3	111.178 6	47.242 5	.00891 7	.6797 9	12.46410 1	-.8E-4 2	7.787250	22 2	.54	
38103.0	184.4 4	107.940 9	47.233 6	.00848 6	.138 1	12.46415 2	.5E-4 5	7.790567	19 2	.77	
38104.0	189.9 3	104.680 6	47.239 4	.00775 5	.5977 9	12.464048 8	-.2E-4 2	7.796345	24 2	.70	
38105.0	197.4 9	101.422 8	47.244 7	.0072 1	.052 3	12.46409 1	-.4E-4 3	7.800502	25 2	1.30	
38106.0	204. 1	98.170 8	47.248 8	.00665 2	.509 4	12.46414 2	-.2E-4 3	7.805885	25 2	1.78	
38107.0	211.2 5	94.909 3	47.245 3	.00625 6	.964 1	12.46425 1	-.13E-3 2	7.808099	27 2	.75	
38108.0	217.4 6	91.654 4	47.244 3	.00568 7	.422 2	12.46422 1	-.11E-3 2	7.812524	38 2	1.13	
38109.0	224.7 5	88.398 3	47.243 2	.00520 5	.876 1	12.46422 1	-.19E-3 2	7.816307	38 2	.73	
38110.0	233.2 7	85.146 4	47.241 3	.00483 5	.328 2	12.463780 8	-.1E-4 2	7.819436	31 2	.84	
38111.0	243.1 8	81.891 4	47.241 3	.00440 5	.775 2	12.46387 1	.6E-4 2	7.822772	33 2	.82	
38112.0	252.0 5	78.625 3	47.237 2	.00390 3	.226 1	12.463984 6	.3E-4 1	7.826607	33 2	.41	
38113.0	267. 1	75.381 6	47.246 3	.00375 4	.661 3	12.464093 5	.9E-4 1	7.827762	35 2	.66	
38114.0	284. 2	72.099 9	47.221 5	.00314 6	.088 6	12.46421 1	.11E-3 2	7.832504	35 2	.80	
38115.0	296. 1	68.877 5	47.243 5	.00328 2	.531 4	12.46440 1	-.9E-4 2	7.831335	25 2	.50	
38116.0	310. 2	65.606 9	47.218 7	.00301 3	.968 6	12.46439 1	.9E-4 2	7.833443	31 2	.97	
38117.0	317. 2	62.35 1	47.239 5	.00285 3	.424 5	12.46458 1	.13E-3 2	7.834643	31 2	.74	
38118.0	343. 2	59.096 8	47.224 6	.00332 3	.827 4	12.4647 1	-.1E-3 2	7.830889	14 1	.55	
38119.0	358. 1	55.834 8	47.220 5	.00375 8	.263 4	12.4651 1	-.1E-3 1	7.827325	15 1	.44	

Table 5

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38030.	1128.	-44.8	44.3	312.4	0.116E-05
38031.	1134.	-45.8	43.9	313.4	0.142E-05
38032.	1139.	-46.5	43.6	314.2	0.386E-06
38033.	1142.	-47.0	43.0	315.4	0.772E-06
38034.	1146.	-47.3	42.2	316.9	0.142E-05
38035.	1151.	-47.2	41.4	318.3	0.167E-05
38036.	1155.	-46.8	40.2	320.0	0.773E-06
38037.	1159.	-46.1	39.3	321.2	0.142E-05
38038.	1163.	-45.0	37.8	323.0	0.515E-06
38039.	1166.	-43.9	37.0	323.6	-0.129E-06
38040.	1169.	-42.4	36.0	324.4	0.644E-06
38041.	1172.	-40.7	35.1	324.9	0.644E-06
38042.	1176.	-38.4	33.5	326.2	-0.103E-05
38043.	1178.	-36.4	33.1	326.0	-0.129E-06
38044.	1180.	-34.3	33.0	325.5	0.258E-06
38045.	1182.	-32.0	32.9	325.0	0.258E-06
38046.	1184.	-29.3	32.9	324.7	0.515E-06
38047.	1186.	-26.7	33.5	323.9	0.129E-06
38048.	1187.	-24.0	34.4	322.9	0.386E-06
38049.	1189.	-21.0	35.3	322.2	-0.258E-08
38050.	1191.	-18.1	36.8	321.0	-0.129E-06
38051.	1193.	-15.0	38.4	320.0	0.129E-07
38052.	1194.	-12.0	40.4	318.6	0.129E-06

Table 5 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
38053.	1195.	-9.0	42.7	317.2	0.386E-06
38054.	1196.	-6.0	45.0	315.7	0.258E-06
38055.	1198.	-3.2	47.6	314.0	-0.129E-06
38056.	1200.	-0.1	50.1	312.6	-0.129E-06
38057.	1201.	3.2	52.6	311.3	0.644E-06
38058.	1202.	6.2	55.1	309.9	-0.258E-06
38059.	1204.	9.2	57.7	308.4	-0.644E-06
38060.	1206.	12.1	60.2	306.9	-0.155E-05
38061.	1208.	15.0	62.7	305.5	-0.901E-06
38062.	1210.	17.6	65.2	303.9	-0.142E-05
38063.	1213.	20.5	67.4	302.8	-0.129E-06
38064.	1215.	23.0	69.6	301.4	-0.901E-06
38065.	1218.	25.4	71.6	300.1	-0.106E-05
38066.	1222.	27.9	73.4	299.1	-0.116E-05
38067.	1225.	30.2	75.2	298.0	-0.116E-05
38068.	1229.	32.4	76.7	297.1	-0.103E-05
38069.	1233.	34.3	78.2	296.0	-0.116E-05
38070.	1239.	36.4	79.2	295.6	-0.142E-05
38071.	1243.	38.0	80.4	294.8	-0.180E-05
38072.	1247.	39.7	81.2	294.3	-0.103E-05
38073.	1255.	41.2	81.8	294.1	0.901E-06
38074.	1259.	42.7	82.2	294.1	-0.129E-06
38075.	1264.	43.8	82.6	293.9	-0.386E-06
38076.	1269.	44.9	82.6	294.1	0.257E-06

Table 5 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	φ	ψ	D.R.A.	\dot{P}
38077.	1277.	45.7	82.6	294.3	0.257E-06
38078.	1281.	46.3	82.5	294.5	0.103E-05
38079.	1287.	46.9	82.0	295.2	0.901E-06
38080.	1294.	47.1	81.4	296.0	-0.386E-06
38081.	1299.	47.2	80.8	296.6	0.129E-06
38082.	1305.	47.1	79.9	297.5	0.772E-06
38083.	1310.	46.7	79.0	298.3	0.103E-06
38084.	1316.	46.2	78.0	298.9	0.515E-06
38085.	1324.	45.4	77.1	299.4	-0.386E-06
38086.	1330.	44.3	75.8	300.3	0.116E-05
38087.	1334.	43.1	74.6	300.7	-0.129E-06
38088.	1340.	41.7	73.5	301.0	0.644E-06
38089.	1345.	40.1	72.3	301.2	-0.129E-06
38090.	1351.	38.2	71.0	301.4	0.257E-06
38091.	1356.	36.1	69.8	301.4	-0.129E-06
38092.	1362.	33.8	68.6	301.5	0.257E-06
38093.	1367.	31.4	67.7	301.1	0.515E-06
38094.	1371.	28.9	66.9	300.6	-0.515E-06
38095.	1376.	26.0	65.9	300.3	0.129E-06
38096.	1382.	22.9	65.0	300.0	-0.129E-06
38097.	1385.	19.9	64.7	299.1	-0.386E-06
38098.	1390.	16.4	64.0	298.8	-0.386E-06
38099.	1395.	12.7	63.4	298.4	0.644E-06

Table 5 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 IOTA 1

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
38100.	1400.	8.6	62.9	298.1	0.116E-05
38101.	1405.	4.1	62.1	298.2	-0.772E-06
38102.	1409.	1.2	63.3	296.8	0.103E-05
38103.	1412.	-3.2	63.2	296.7	-0.644E-06
38104.	1418.	-7.3	63.6	296.3	0.257E-06
38105.	1423.	-12.7	62.9	297.4	0.515E-06
38106.	1429.	-17.4	62.9	298.0	0.257E-06
38107.	1433.	-22.4	62.6	299.4	0.167E-05
38108.	1438.	-26.5	62.9	300.3	0.142E-05
38109.	1444.	-31.1	62.5	302.6	0.245E-05
38110.	1448.	-36.0	61.2	306.8	0.129E-06
38111.	1454.	-40.9	59.1	313.6	-0.772E-06
38112.	1459.	-44.3	57.3	320.6	-0.386E-06
38113.	1461.	-47.2	52.4	337.6	-0.116E-05
38114.	1465.	-45.4	47.3	358.0	-0.142E-05
38115.	1462.	-41.3	44.4	9.4	0.116E-05
38116.	1462.	-34.2	41.6	20.6	-0.116E-05
38117.	1462.	-30.0	39.7	23.0	-0.167E-05
38118.	1453.	-12.4	42.3	39.5	0.129E-05
38119.	1449.	-1.5	46.0	45.7	0.129E-05

Satellite 1960 Xi 1 (Explorer VIII)

Phyllis Stem

I. SAO smoothed elements

The following elements are based on 155 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38046.0 \text{ MJD}$$

$$\omega = (151^\circ 299 \pm 6) + (2^\circ 8160 \pm 5)t + .0001593t^2 + .3431 \cos \omega$$

$$\Omega = (176^\circ 491 \pm 1) - (3^\circ 3893 \pm 1)t + .4115 \times 10^{-5}t^2 + .0143 \cos \omega$$

$$i = (49^\circ 9497 \pm 8) + .3685 \times 10^{-4}t - .0043 \sin \omega$$

$$e = (.119256 \pm 9) - .1052 \times 10^{-4}t + .0007285 \sin \omega$$

$$M = (.74389 \pm 2) + (12.809531 \pm 2)t + (.1860 \pm 3) \times 10^{-4}t^2 - (.49 \pm 3) \times 10^{-7}t^2$$

$$- .0008799 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.28$.

The following elements are based on 217 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38075.0 \text{ MJD}$$

$$\omega = (232^\circ 990 \pm 7) + (2^\circ 8183 \pm 6)t + .0001593t^2 + .3431 \cos \omega$$

$$\Omega = (78^\circ 211 \pm 1) - (3^\circ 3884 \pm 1)t + (.4115 \times 10^{-5})t^2 + .0143 \cos \omega$$

$$i = (49^\circ 9514 \pm 9) + .3685 \times 10^{-4}t - .0043 \sin \omega$$

$$e = (.119094 \pm 7) - .1052 \times 10^{-4}t + .0007285 \sin \omega$$

$$M = (.23502 \pm 2) + (12.810463 \pm 2)t + (.1053 \pm 3) \times 10^{-4}t^2 - (.115 \pm 4) \times 10^{-6}t^2 - .0008799 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.33$.

The following elements are based on 198 observations and are valid for the period March 1 through April 1, 1963.

$$T_o = 38105.0 \text{ MJD}$$

$$\omega = (317^\circ 461 \pm 3) + (2^\circ 8149 \pm 3)t + .0001593t^2 + .3431 \cos \omega$$

$$\Omega = (336^\circ 547 \pm 1) - (3^\circ 3894 \pm 1)t + .4115 \times 10^{-5}t^2 + .0143 \cos \Omega$$

$$i = (49^\circ 9512 + 7) + .3685 \times 10^{-4}t - .0043 \sin \omega$$

$$e = (.11909 \pm 1) - .1052 \times 10^{-4}t + .0007285 \sin \omega$$

$$M = (.55792 \pm 1) + (12.8110740 \pm 9)t + (.786 \pm 2) \times 10^{-5}t^2 - (.129 \pm 2) \\ \times 10^{-6}t^3 - .0008799 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.23$.

II. SAO mean elements - Satellite 1960 Xi 1

1 January - 30 March 1963

T (MJD)	Ψ	Ω	i	e	M	n	$n'/2$	q	N	D	σ
38030.0	106.201	7	230.708	2	49.943	2	.111994	3	.79636	2	.12.809033
38034.0											.3
38038.0											.58
38042.0											
38046.0	151.07	2	176.479	3	49.947	3	.111951	2	.74441	7	.12.809525
38050.0	162.26	2	162.919	2	49.945	2	.111941	2	.98308	5	.12.809690
38054.0	173.50	2	149.365	2	49.949	1	.111927	2	.22218	5	.12.809830
38058.0	184.79	2	135.804	3	49.952	1	.111907	1	.46167	5	.12.809955
38062.0	196.03	1	122.251	2	49.950	2	.111894	1	.70193	4	.12.810122
38066.0	207.31	2	108.703	4	49.951	3	.111880	1	.94266	6	.12.810230
38070.0	218.61	6	95.144	6	49.956	9	.111869	2	.1837	2	.12.810328
38074.0	229.99	2	81.588	1	49.958	2	.1118528	9	.42500	5	.12.810437
38078.0	241.30	1	68.039	1	49.956	1	.111843	1	.66688	4	.12.810508
38082.0	252.62	1	54.488	1	49.957	1	.111837	2	.90902	4	.12.810574
38086.0	263.94	1	40.937	2	49.958	2	.111832	2	.15142	4	.12.810644
38090.0	275.28	1	27.382	2	49.952	2	.111828	2	.39405	3	.12.810712
38094.0	286.596	8	13.829	3	49.956	2	.111838	2	.63707	2	.12.810791
38098.0	297.94	1	•276	4	49.955	2	.111836	3	.88075	3	.12.810891
38102.0	309.25	1	346.724	6	49.952	2	.111847	3	.12417	4	.12.810977
38106.0	320.58	1	333.182	4	49.945	3	.111856	3	.36d18	4	.12.811030
38110.0	331.93	1	319.615	4	49.954	4	.111873	4	.6124	4	.12.811080
38114.0	343.109	8	306.060	2	49.944	3	.111888	2	.85736	3	.12.811126
38118.0	354.431	6	292.501	2	49.947	2	.111898	2	.10204	2	.12.811174

Table 6
RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1960 XI 1

MJD	Z	Φ	$\dot{\Phi}$	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38030.	424.	47.3	91.0	64.3	-0.146E-06
38046.	418.	21.7	57.0	38.7	-0.280E-06
38050.	417.	13.5	44.0	28.9	-0.219E-06
38054.	417.	5.0	30.3	18.5	-0.183E-06
38058.	418.	-3.7	16.5	8.1	-0.207E-06
38062.	420.	-12.2	5.3	357.8	-0.256E-06
38066.	423.	-20.6	12.2	348.1	-0.146E-06
38070.	426.	-28.5	23.6	339.4	-0.219E-06
38074.	430.	-35.9	33.7	332.2	-0.172E-06
38078.	433.	-42.2	41.7	326.9	-0.102E-06
38082.	435.	-46.9	47.5	323.9	-0.119E-06
38086.	436.	-49.6	50.8	323.1	-0.117E-06
38090.	437.	-49.7	52.0	323.4	-0.134E-06
38094.	435.	-47.2	52.0	322.8	-0.134E-06
38098.	433.	-42.6	51.9	320.2	-0.171E-06
38102.	430.	-36.4	53.1	315.2	-0.658E-07
38106.	427.	-29.1	56.4	308.3	-0.816E-07
38110.	423.	-21.1	62.2	300.1	-0.621E-07
38114.	420.	-12.8	70.2	290.8	-0.119E-06
38118.	419.	-4.3	79.3	281.0	-0.621E-07

Satellite 1961 Delta 1 (Explorer IX)

Maria Gutierrez

I. SAO smoothed elements

The following elements are based on 122 observations and are valid for the period January 1 through January 16, 1963.

$$T_o = 38036.0 \text{ MJD}$$

$$\omega = (163^\circ 241 \pm 9) + (4^\circ 854 \pm 2)t - .000284t^2 + .2484 \cos \omega$$

$$\Omega = (179^\circ 240 \pm 2) - (3^\circ 6974 \pm 4)t - .000194t^2 + .0066 \cos \omega$$

$$i = (38^\circ 866 \pm 1) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.11746 \pm 2) + (.39 \pm 3) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.88169 \pm 3) + (12.252537 \pm 6)t + (.770 \pm 4) \times 10^{-4}t^2 + (.35 \pm 8) \times 10^{-6}t^3 \\ + (.212 \pm 8) \times 10^{-6}t^4 - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.33$.

The following elements are based on 159 observations and are valid for the period January 16 through January 31, 1963.

$$T_o = 38052.0 \text{ MJD}$$

$$\omega = (240^\circ 906 \pm 5) + (4^\circ 854 \pm 1)t - .000284t^2 + .2484 \cos \omega$$

$$\Omega = (120^\circ 060 \pm 2) - (3^\circ 7006 \pm 4)t - .000194t^2 + .0066 \cos \omega$$

$$i = (38^\circ 8705 \pm 6) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.11829 \pm 1) + (.73 \pm 3) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.95193 \pm 2) + (12.256663 \pm 4)t + (.0001407 \pm 3)t^2 - (.39 \pm 28) \times 10^{-7}t^3 \\ + (.75 \pm 5) \times 10^{-7}t^4 - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.08$.

The following elements are based on 125 observations and are valid for the period February 1 through February 15, 1963.

$$T_o = 38067.0 \text{ MJD}$$

$$\omega = (313^\circ 68 \pm 1) + (4^\circ 855 \pm 2)t - .000284t^2 + .2484 \cos \omega$$

$$\Omega = (64^\circ 506 \pm 3) - (3^\circ 7050 \pm 6)t - .000194t^2 + .0066 \cos \omega$$

$$i = (38^\circ 879 \pm 2) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.11939 \pm 3) + (.67 \pm 7) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.83825 \pm 3) + (12.261760 \pm 6)t + (.0001796 \pm 4)t^2 + (.159 \pm 8) \times 10^{-5}t^3 \\ + (.96 \pm 11) \times 10^{-7}t^4 - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.48$.

The following elements are based on 130 observations and are valid for the period February 15 through March 1, 1963.

$$T_o = 38081.0 \text{ MJD}$$

$$\omega = (21^\circ 698 \pm 5) + (4^\circ 8615 \pm 8)t - .000284t^2 + .2484 \cos \omega$$

$$\Omega = (12^\circ 587 \pm 2) - (3^\circ 7114 \pm 4)t - .000194t^2 + .0066 \cos \omega$$

$$i = (38^\circ 8761 \pm 9) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.12044 \pm 2) + (.87 \pm 4) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.54228 \pm 1) + (12.267412 \pm 2)t + (.0002056 \pm 3)t^2 + (.66 \pm 3) \times 10^{-6}t^3 \\ - (.79 \pm 5) \times 10^{-7}t^4 - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.23$.

The following elements are based on 120 observations and are valid for the period March 1 through March 16, 1963.

$$T_o = 38096.0 \text{ MJD}$$

$$\omega = (94^\circ 573 \pm 6) + (4^\circ 853 \pm 1)t - .000284t^2 + .2484 \cos \omega$$

$$\Omega = (316^\circ 857 \pm 3) - (3^\circ 7190 \pm 7)t - .000194t^2 + .0066 \cos \omega$$

$$i = (38^\circ 879 \pm 1) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.12170 \pm 3) + (.76 \pm 6) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.59950 \pm 2) + (12.273640 \pm 3)t + (.0002440 \pm 6)t^2 + (.242 \pm 5) \times 10^{-5}t^3 \\ - (.26 \pm 1) \times 10^{-6}t^4 - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.98$.

The following elements are based on 148 observations and are valid for the period March 16 through April 1, 1963.

$$T_o = 38111.0 \text{ MJD}$$

$$\omega = (167^\circ 505 \pm 4) + (4^\circ 8757 \pm 8)t - .000284t^2 \pm .2484 \cos \omega$$

$$\Omega = (261^\circ 026 \pm 1) - (3^\circ 7250 \pm 4)t - .000194t^2 \pm .0066 \cos \omega$$

$$i = (38^\circ 8851 \pm 9) + .830 \times 10^{-4}t - .0045 \sin \omega$$

$$e = (.12276 \pm 1) + (.70 \pm 3) \times 10^{-4}t + .95 \times 10^{-6}t^2 + .0005258 \sin \omega$$

$$M = (.75733 \pm 1) + (12.280659 \pm 2)t + (.0002412 \pm 1)t^2 + (.67 \pm 18) \times 10^{-7}t^3 \\ - .0006974 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.18.$

II. SAO mean elements - Satellite 1961 Delta 1

1-31 January 1963

Γ (MJD)	W	Ω	i	e	M	n	$n^{1/2}$	q	N	D	σ
38030.0	133.94 5	201.421 7	38.855 2	.11751 9	.3698 2	12.2516 2	*76E-4 9	7.013355	16 4	.43	
38031.0	138.78 3	197.724 4	38.856 1	.11753 5	.62150 8	12.25174 6	*72E-4 4	7.013158	26 4	.38	
38032.0	143.62 2	194.523 4	38.858 1	.11756 5	.87340 7	12.25194 5	*69E-4 4	7.012848	33 4	.42	
38033.0	148.46 1	190.323 3	38.860 1	.11758 3	.12541 4	12.25210 5	*78E-4 4	7.012603	35 4	.44	
38034.0	153.29 2	186.625 4	38.861 2	.11762 3	.37760 6	12.25225 7	*92E-4 6	7.012226	31 4	.45	
38035.0	158.18 4	182.934 8	38.864 2	.11770 7	.62976 2	12.25226 1	*92E-4 7	7.011585	23 4	.45	
38036.0	163.04 6	179.246 7	38.866 5	.11764 5	.8822 2	12.25252 1	*75E-4 7	7.011962	18 4	.58	
38037.0	167.9 1	175.550 7	38.858 9	.11766 7	.1346 4	12.2524 3	*78E-4 7	7.011840	21 4	.59	
38038.0	172.71 6	171.840 5	38.866 4	.11757 4	.3877 2	12.25229 1	*95E-4 5	7.012321	24 4	.45	
38039.0	177.53 4	168.140 4	38.868 4	.11761 4	.6408 1	12.2530 1	*84E-4 5	7.011982	27 4	.49	
38040.0	182.38 2	164.438 3	38.866 3	.11761 3	.89397 5	12.2533 1	*81E-4 3	7.011857	28 4	.33	
38041.0	187.26 1	160.740 2	38.870 2	.11767 2	.14720 4	12.25345 3	*114E-3 3	7.011386	39 4	.37	
38042.0	192.11 2	157.042 2	38.871 2	.11761 3	.40071 6	12.25368 6	*146E-3 3	7.011743	40 4	.34	
38043.0	196.954 9	153.244 2	38.872 1	.11763 2	.65454 3	12.25393 4	*164E-3 2	7.011514	44 4	.29	
38044.0	201.84 1	149.647 2	38.873 1	.11763 2	.90856 4	12.25421 3	*165E-3 2	7.011356	43 4	.29	
38045.0	206.69 1	145.948 2	38.873 1	.11761 2	.16302 4	12.25459 3	*158E-3 2	7.011030	38 4	.30	
38046.0	211.56 2	142.651 2	38.872 9	.11763 2	.41772 5	12.25492 4	*156E-3 2	7.011132	47 4	.35	
38047.0	216.42 1	138.553 2	38.873 1	.11765 2	.67276 3	12.25522 3	*151E-3 2	7.010837	50 4	.40	
38048.0	221.292 8	134.654 2	38.8727 9	.11767 2	.92808 3	12.25551 3	*154E-3 2	7.010565	50 4	.38	
38049.0	226.16 1	131.157 3	38.8730 9	.11771 2	.18370 4	12.25581 4	*150E-3 3	7.010154	49 4	.39	
38050.0	231.04 1	127.457 3	38.8729 9	.11775 2	.43961 3	12.25610 2	*138E-3 3	7.009734	42 4	.38	
38051.0	235.91 1	123.612 3	38.8739 8	.11781 2	.69582 3	12.25638 3	*137E-3 2	7.009142	35 4	.29	
38052.0	240.79 1	120.059 4	38.875 1	.11785 3	.95227 3	12.25666 3	*135E-3 3	7.008705	36 4	.36	
38053.0	245.67 1	116.355 3	38.871 1	.11792 2	.20899 3	12.25695 3	*148E-3 3	7.008075	33 4	.38	
38054.0	250.54 1	112.654 5	38.876 2	.11797 3	.46602 5	12.25726 4	*150E-3 3	7.007529	30 4	.44	
38055.0	255.40 2	108.876 8	38.876 1	.11804 4	.72335 5	12.25754 4	*154E-3 4	7.006885	33 4	.42	
38056.0	260.28 1	105.263 8	38.876 1	.11812 4	.98094 5	12.25784 3	*144E-3 3	7.006078	41 4	.41	
38057.0	265.15 9	101.554 6	38.876 1	.11815 3	.23887 3	12.25811 3	*144E-3 3	7.005794	43 4	.39	
38058.0	270.027 8	97.847 6	38.871 1	.11822 3	.49707 3	12.25838 5	*147E-3 3	7.005121	44 4	.35	
38059.0	274.87 2	94.147 8	38.875 2	.11830 6	.75565 7	12.25879 6	*180E-3 3	7.004275	42 4	.48	
38060.0	279.8 2	90.444 1	38.875 3	.1182 1	.0142 9	12.2591 6	*223E-3 3	7.004702	32 4	.44	

II. SAO mean elements - Satellite 1961 Delta 1

1-28 February 1963

(MJD)	ω	Ω	1	e	M	n	$n^{1/2}$	q	N	D	σ
38061.0	284.4 2	86.74 2	38.870 6	•1184 1	•2746 9	12.2595 6	•228E-3 4	7.003431	31	4	.47
38062.0	289.0 2	83.04 1	38.875 5	•1185 1	•5345 5	12.2591 5	•19E-3 4	7.002757	32	4	.43
38063.0	294.35 2	79.33 1	38.876 4	•11856 6	•79370 6	12.2604 5	•184E-3 3	7.001624	33	4	.37
38064.0	299.20 2	75.638 9	38.874 4	•11864 6	•05426 5	12.26075 4	•180E-3 3	7.000903	35	4	.35
38065.0	304.12 1	71.915 5	38.882 3	•11887 5	•31502 4	12.26106 3	•171E-3 3	6.998947	32	4	.35
38066.0	308.99 2	68.215 4	38.882 3	•11895 6	•57623 4	12.26139 4	•170E-3 4	6.998185	30	4	.45
38067.0	313.85 1	64.514 4	38.880 3	•11899 7	•83780 4	12.26179 4	•173E-3 4	6.997690	26	4	.48
38068.0	318.71 1	60.811 3	38.881 3	•11910 5	•09972 3	12.26214 3	•174E-3 3	6.996657	33	4	.45
38069.0	323.583 9	57.107 3	38.880 3	•11925 4	•36194 3	12.26247 3	•180E-3 3	6.995379	33	4	.46
38070.0	328.46 1	53.398 3	38.886 3	•11938 4	•62451 3	12.26291 3	•212E-3 3	6.994147	34	4	.58
38071.0	333.317 8	49.693 2	38.883 2	•11947 3	•88759 2	12.26329 2	•229E-3 3	6.993293	32	4	.41
38072.0	338.183 5	45.986 2	38.883 2	•11963 2	•15107 2	12.26377 1	•227E-3 1	6.991836	31	4	.29
38073.0	343.046 5	42.273 2	38.882 2	•11969 2	•41505 2	12.26417 1	•218E-3 1	6.991223	38	4	.33
38074.0	347.910 6	38.565 2	38.881 2	•11981 2	•67944 2	12.26461 2	•215E-3 2	6.990096	41	4	.35
38075.0	352.772 6	34.857 2	38.880 2	•11991 2	•94426 2	12.26504 2	•210E-3 2	6.989116	45	4	.37
38076.0	357.641 8	31.147 3	38.877 2	•12006 3	•20948 2	12.26543 2	•202E-3 2	6.987823	39	4	.44
38077.0	2.50 1	27.436 5	38.876 3	•12016 3	•47514 3	12.26582 2	•196E-3 2	6.986851	40	4	.52
38078.0	7.35 1	23.730 5	38.879 2	•12021 3	•74120 2	12.26626 2	•195E-3 2	6.986336	45	4	.51
38079.0	12.21 1	20.017 6	38.878 2	•12032 4	•00762 3	12.26662 2	•197E-3 3	6.985324	42	4	.55
38080.0	17.06 1	16.305 8	38.878 2	•12044 5	•27445 3	12.26701 2	•199E-3 2	6.984188	38	4	.50
38081.0	21.92 2	12.600 8	38.874 2	•12065 5	•54165 3	12.26738 2	•205E-3 2	6.982353	34	4	.47
38082.0	26.80 1	8.876 8	38.871 2	•12084 5	•80923 3	12.26793 2	•210E-3 2	6.980712	26	4	.50
38083.0	31.64 1	5.170 7	38.871 2	•12096 4	•07730 2	12.26827 2	•213E-3 2	6.979560	26	4	.43
38084.0	36.48 1	1.456 6	38.872 2	•12111 5	•34581 2	12.26867 2	•210E-3 2	6.939828	27	4	.46
38085.0	41.34 2	357.75 1	38.876 3	•12103 8	•61473 4	12.26905 3	•183E-3 5	6.978718	28	4	.92
38086.0	46.155 6	354.029 4	38.872 1	•12138 4	•88406 1	12.26945 1	•198E-3 3	6.975777	23	4	.31
38087.0	51.028 7	350.313 4	38.869 2	•12153 5	•15371 2	12.26977 2	•185E-3 3	6.974513	27	4	.42
38088.0	55.90 1	346.599 6	38.871 2	•12154 5	•42368 3	12.27030 2	•225E-3 4	6.974189	39	4	.68

II. SAO mean elements - Satellite 1961 Delta 1

T (MJD)	w	Ω	i	e	M	n	$n'/2$	q	N	D	σ
38089.0	60.67 2	342.887 5	38.873 2	*12167 5	*69449 4	12.27058 5	*219E-3 .6	6.973094	42	4	.67
38090.0	65.541 4	339.167 2	38.873 7	*12174 2	*965315 9	12.27110 1	*209E-3 2	6.972304	40	4	.29
38091.0	70.378 4	335.451 2	38.874 7	*12186 2	*236669 8	12.271492 7	*201E-3 1	6.971214	46	4	.31
38092.0	75.219 4	331.732 2	38.874 7	*12196 2	*508423 9	12.271902 6	*200E-3 1	6.970274	39	4	.32
38093.0	80.056 5	328.011 2	38.875 9	*12206 2	*78058 1	12.27231 1	*201E-3 2	6.969355	36	4	.35
38094.0	84.897 5	324.292 3	38.874 1	*12211 3	*05314 1	12.27271 1	*206E-3 2	6.968742	39	4	.41
38095.0	89.731 6	320.570 3	38.875 1	*12223 3	*32611 1	12.27313 1	*215E-3 2	6.967648	32	4	.43
38096.0	94.570 8	316.854 4	38.875 2	*12231 4	*59950 2	12.27357 2	*233E-3 3	6.966888	30	4	.59
38097.0	99.405 7	313.135 5	38.875 2	*12231 4	*87337 2	12.27409 2	*261E-3 4	6.966693	30	4	.49
38098.0	104.23 1	309.418 8	38.877 2	*12237 5	*14782 4	12.27463 4	*264E-3 5	6.965985	26	4	.44
38099.0	109.064 8	305.692 4	38.877 2	*12245 4	*42279 3	12.27517 1	*265E-3 4	6.965150	26	4	.45
38100.0	113.885 7	301.979 5	38.877 2	*12252 4	*69831 2	12.27565 2	*245E-3 3	6.964437	29	4	.46
38101.0	118.730 6	298.261 3	38.876 2	*12264 4	*97423 1	12.27610 2	*217E-3 4	6.963273	24	4	.41
38102.0	123.581 6	294.544 5	38.875 2	*12261 4	*25059 2	12.27651 2	*213E-3 3	6.962954	23	4	.40
38103.0	128.428 7	290.818 4	38.874 2	*12265 3	*52741 2	12.27699 2	*220E-3 3	6.962857	23	4	.41
38104.0	133.270 9	287.091 6	38.874 2	*12264 4	*80469 3	12.27747 2	*222E-3 3	6.962734	18	4	.42
38105.0	138.08 1	283.375 7	38.871 3	*12260 6	*08248 4	12.27799 4	*226E-3 7	6.962869	16	4	.46
38106.0	142.96 1	279.641 7	38.879 4	*12273 6	*36050 4	12.27829 2	*227E-3 5	6.961748	20	4	.63
38107.0	148.80 1	275.913 7	38.887 3	*12284 6	*63907 4	12.27872 3	*250E-3 6	6.960679	25	4	.56
38108.0	152.678 9	272.190 4	38.886 2	*12283 4	*91805 3	12.27926 3	*242E-3 4	6.960577	35	4	.49
38109.0	157.535 6	268.469 2	38.885 2	*12286 3	*19758 2	12.27974 2	*240E-3 3	6.960197	42	4	.46
38110.0	162.395 5	264.747 2	38.886 1	*12287 2	*47759 1	12.28020 1	*224E-3 2	6.959931	46	4	.43
38111.0	167.259 5	261.022 2	38.884 1	*12289 2	*75803 1	12.28065 1	*232E-3 3	6.959579	47	4	.46
38112.0	172.128 5	257.295 2	38.885 1	*12292 2	*03892 1	12.28115 1	*250E-3 2	6.959143	45	4	.43
38113.0	176.999 5	253.568 2	38.886 1	*12294 2	*32030 1	12.28163 1	*250E-3 2	6.958827	43	4	.38
38114.0	181.876 5	249.839 2	38.885 1	*12295 2	*60219 1	12.28211 1	*240E-3 2	6.958518	46	4	.41
38115.0	186.752 5	246.114 3	38.885 2	*12298 2	*88454 1	12.28260 1	*237E-3 2	6.958131	42	4	.41
38116.0	191.626 6	242.388 3	38.886 2	*12301 2	*16737 1	12.28310 1	*239E-3 2	6.957712	43	4	.42
38117.0	196.505 5	238.661 3	38.886 2	*12304 2	*45067 1	12.28357 1	*242E-3 2	6.957263	44	4	.40
38118.0	201.380 6	234.934 4	38.889 2	*12310 2	*73445 2	12.28403 1	*245E-3 2	6.956648	38	4	.40
38119.0	206.270 6	231.207 4	38.889 2	*12313 3	*01869 2	12.28451 2	*244E-3 3	6.956210	35	4	.41

Table 7

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38030.	639.	26.9	77.8	61.8	-0.101E-05
38031.	638.	24.4	76.3	61.6	-0.959E-06
38032.	637.	21.8	74.6	61.3	-0.919E-06
38033.	637.	19.2	72.7	60.7	-0.104E-05
38034.	636.	16.4	70.6	60.1	-0.123E-05
38035.	634.	13.5	68.4	59.4	-0.123E-05
38036.	634.	10.5	66.2	58.6	-0.999E-06
38037.	634.	7.6	63.9	57.7	-0.104E-05
38038.	634.	4.6	61.5	56.6	-0.127E-05
38039.	634.	1.5	59.1	55.6	-0.112E-05
38040.	633.	-1.5	56.9	54.6	-0.108E-05
38041.	633.	-4.5	54.7	53.6	-0.152E-05
38042.	634.	-7.6	52.6	52.7	-0.194E-05
38043.	634.	-10.5	50.7	51.8	-0.218E-05
38044.	634.	-13.5	49.0	51.0	-0.220E-05
38045.	635.	-16.4	47.6	50.2	-0.210E-05
38046.	635.	-19.2	46.5	49.6	-0.208E-05
38047.	635.	-21.9	45.6	49.2	-0.201E-05
38048.	636.	-24.5	45.1	48.9	-0.205E-05
38049.	636.	-26.9	45.0	48.8	-0.200E-05
38050.	636.	-29.2	45.1	48.9	-0.184E-05
38051.	637.	-31.3	45.5	49.3	-0.182E-05
38052.	637.	-33.2	46.2	49.8	-0.180E-05

Table 7 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
38053.	637.	-34.9	47.1	50.6	-0.197E-05
38054.	637.	-36.3	48.1	51.6	-0.200E-05
38055.	636.	-37.4	49.3	52.7	-0.205E-05
38056.	636.	-38.2	50.6	54.1	-0.192E-05
38057.	636.	-38.7	52.0	55.6	-0.192E-05
38058.	635.	-38.9	53.3	57.1	-0.196E-05
38059.	634.	-38.7	54.6	58.6	-0.240E-05
38060.	635.	-38.2	55.9	60.1	-0.297E-05
38061.	633.	-37.4	56.8	61.1	-0.303E-05
38062.	632.	-36.3	57.8	62.2	-0.265E-05
38063.	630.	-34.9	59.0	63.6	-0.245E-05
38064.	629.	-33.2	59.8	64.4	-0.239E-05
38065.	626.	-31.3	60.6	65.0	-0.227E-05
38066.	625.	-29.2	61.1	65.4	-0.226E-05
38067.	624.	-26.9	61.5	65.5	-0.230E-05
38068.	622.	-24.5	61.8	65.5	-0.231E-05
38069.	620.	-21.9	61.9	65.3	-0.239E-05
38070.	618.	-19.2	61.9	64.9	-0.282E-05
38071.	617.	-16.4	61.9	64.4	-0.305E-05
38072.	615.	-13.5	61.7	63.8	-0.302E-05
38073.	614.	-10.5	61.5	63.0	-0.290E-05
38074.	612.	-7.6	61.3	62.2	-0.286E-05
38075.	611.	-4.5	61.1	61.4	-0.279E-05
38076.	609.	-1.5	60.9	60.5	-0.269E-05

Table 7 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
38077.	608.	1.6	60.7	59.6	-0.261E-05
38078.	608.	4.6	60.7	58.7	-0.259E-05
38079.	607.	7.6	60.7	57.8	-0.262E-05
38080.	607.	10.6	60.8	57.0	-0.264E-05
38081.	605.	13.6	61.0	56.3	-0.272E-05
38082.	604.	16.4	61.4	55.7	-0.279E-05
38083.	603.	19.2	61.8	55.2	-0.283E-05
38084.	564.	21.9	62.4	54.9	-0.279E-05
38085.	604.	24.5	63.2	54.7	-0.243E-05
38086.	602.	26.9	64.0	54.6	-0.263E-05
38087.	601.	29.2	65.0	54.9	-0.246E-05
38088.	602.	31.3	66.0	55.3	-0.299E-05
38089.	601.	33.2	67.0	55.8	-0.291E-05
38090.	601.	34.8	68.2	56.7	-0.278E-05
38091.	600.	36.2	69.3	57.7	-0.267E-05
38092.	600.	37.4	70.4	59.0	-0.266E-05
38093.	599.	38.2	71.5	60.3	-0.267E-05
38094.	599.	38.7	72.5	61.8	-0.274E-05
38095.	598.	38.9	73.4	63.4	-0.285E-05
38096.	597.	38.7	74.2	64.9	-0.309E-05
38097.	597.	38.3	74.9	66.4	-0.346E-05
38098.	596.	37.5	75.5	67.8	-0.350E-05
38099.	594.	36.4	75.8	69.1	-0.352E-05
38100.	593.	35.0	76.1	70.1	-0.325E-05

Table 7 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1961 DELTA 1

MJD	Z	Φ	Ψ	D.R.A.	\dot{P}
38101.	591.	33.4	76.2	71.0	-0.288E-05
38102.	590.	31.5	76.1	71.7	-0.283E-05
38103.	590.	29.4	75.8	72.1	-0.292E-05
38104.	589.	27.2	75.4	72.4	-0.295E-05
38105.	588.	24.8	74.8	72.4	-0.300E-05
38106.	586.	22.2	74.1	72.2	-0.301E-05
38107.	585.	19.0	74.1	72.8	-0.332E-05
38108.	584.	16.7	72.5	71.5	-0.321E-05
38109.	583.	13.9	71.5	70.9	-0.318E-05
38110.	582.	10.9	70.6	70.3	-0.297E-05
38111.	582.	8.0	69.6	69.5	-0.308E-05
38112.	581.	4.9	68.7	68.7	-0.332E-05
38113.	580.	1.9	67.9	67.9	-0.331E-05
38114.	580.	-1.2	67.1	67.1	-0.318E-05
38115.	580.	-4.2	66.5	66.2	-0.314E-05
38116.	580.	-7.3	66.0	65.4	-0.317E-05
38117.	580.	-10.3	65.7	64.7	-0.321E-05
38118.	579.	-13.2	65.6	64.0	-0.325E-05
38119.	579.	-16.1	65.8	63.4	-0.323E-05

Satellite 1962 Alpha Epsilon 1 (Telstar I)

Maria Gutierrez

I. SAO smoothed elements

The following elements are based on 62 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38046.0 \text{ MJD}$$

$$\omega = (183^\circ 63 \pm 1) + (1^\circ 9883 \pm 8)t + .93 \times 10^{-5}t^2 + .1142 \cos \omega$$

$$\Omega = (209^\circ 295 \pm 4) - (1^\circ 8587 \pm 4)t - .10 \times 10^{-5}t^2 + .0145 \cos \omega$$

$$i = (44^\circ 793 \pm 2) + .000114t - .0077 \sin \omega$$

$$e = (.24201 \pm 1) - .80 \times 10^{-6}t + .0005183 \sin \omega$$

$$M = (.72515 \pm 2) + (9.126137 \pm 2)t + (.26 \pm 4) \times 10^{-6}t^2 + (.25 \pm 5) \\ \times 10^{-7}t^3 - .0003171 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.40$.

The following elements are based on 140 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38074.0 \text{ MJD}$$

$$\omega = (239^\circ 242 \pm 3) + (1^\circ 9836 \pm 4)t + .93 \times 10^{-5}t^2 + .1142 \cos \omega$$

$$\Omega = (157^\circ 241 \pm 2) - (1^\circ 8588 \pm 2)t - .10 \times 10^{-5}t^2 + .0145 \cos \omega$$

$$i = (44^\circ 7990 \pm 9) + .000114t - .0077 \sin \omega$$

$$e = (.24218 \pm 2) - .80 \times 10^{-6}t + .0005183 \sin \omega$$

$$M = (.257377 \pm 7) + (9.1261637 \pm 9)t + (.60 \pm 3) \times 10^{-6}t^2 - (.44 \pm 37) \\ \times 10^{-8}t^3 - .0003171 \cos \omega$$

Standard error of one observation: $\sigma = \pm 0.98$.

The following elements are based on 221 observations and are valid for the period March 1 through April 1, 1963.

$$T_0 = 38104.0 \text{ MJD}$$

$$\omega = (298.783 \pm 2) + (1.9847 \pm 2)t + .93 \times 10^{-5}t^2 + .1142 \cos \omega$$

$$\Omega = (101.470 \pm 1) - (1.8597 \pm 1)t - .10 \times 10^{-5}t^2 + .0145 \cos \omega$$

$$i = (44.8020 \pm 6) + .000114t - .0077 \sin \omega$$

$$e = (.24241 \pm 2) - .80 \times 10^{-6}t + .0005183 \sin \omega$$

$$M = (.042638 \pm 9) + (9.1261912 \pm 7)t + (.10 \pm 2) \times 10^{-6}t^2 - (.14 \pm 3) \\ \times 10^{-7}t^3 - .0003171 \cos \omega$$

Standard error of one observation: $\sigma = \pm 0.90$.

II. SAO mean elements - Satellite 1962 Alpha Epsilon 1

1 January - 30 March 1963

T (MJD)	ω	Ω	i	e	M	n	$n^{1/2}$	q	N	D	σ
38030.0	151.72 1	239.019 2	44.791 2	.24227 2	.70721 2	9.126152 1	.5E-6 7	7.328802	23	8	.45
38034.0	159.66 1	231.583 2	44.790 2	.24220 1	.21182 2	9.126146 1	-.23E-5 8	7.329462	31	8	.48
38038.0	167.63 3	224.145 5	44.790 5	.24210 3	.71635 5	9.126140 1	-.8E-6 6	7.330468	17	8	.54
38042.0	175.48 6	216.722 8	44.790 9	.24208 5	.22105 9	9.126140 5	.3E-5 2	7.330626	13	8	.87
38046.0	183.4 2	209.28 4	44.624 3	.2422 2	.7255 3	9.12616 1	.18E-4 6	7.329789	16	8	2.22
38050.0	192.7 5	201.66 8	44.669 6	.2393 9	.2393 8	9.12618 3	-.24E-4 7	7.357399	18	8	1.48
38054.0	199.3 3	194.4 1	44.76 1	.2428 8	.7347 3	9.12614 7	.1E-5 3	7.323654	10	8	.30
38058.0											
38062.0	215.38 3	179.52 1	44.810 6	.2415 1	.74378 3	9.12614 1	.6E-5 5	7.336713	8	6	.44
38066.0	223.279 6	172.095 3	44.804 2	.24175 3	.24841 2	9.126154 3	-.2E-5 2	7.333851	14	6	.29
38070.0	231.229 8	164.665 5	44.808 3	.24170 3	.75298 2	9.126148 2	.2E-5 1	7.334366	22	6	.39
38074.0	239.156 6	157.234 3	44.805 2	.24169 4	.25754 1	9.126156 2	.1E-5 1	7.334457	28	6	.41
38078.0	247.142 4	149.797 2	44.807 1	.24180 3	.76211 1	9.126164 2	.2E-5 1	7.333317	42	6	.33
38082.0	255.092 4	142.364 2	44.811 2	.24172 3	.266779 9	9.126166 1	-.6E-6 8	7.334157	35	6	.29
38086.0	263.029 7	134.939 3	44.810 3	.24180 8	.77141 4	9.126164 3	.2E-5 2	7.333323	39	6	.49
38090.0	270.987 5	127.496 5	44.808 2	.24180 5	.27609 2	9.126173 4	.2E-5 2	7.333311	39	6	.49
38094.0	278.955 6	120.058 5	44.810 3	.24184 4	.78073 2	9.126180 4	.3E-5 2	7.332967	33	6	.49
38098.0	286.913 8	112.629 4	44.812 3	.24197 5	.28540 2	9.126178 3	-.1E-5 2	7.331741	30	6	.58
38102.0	294.866 6	105.197 2	44.810 1	.24199 3	.79009 2	9.126185 3	.3E-6 9	7.331493	58	6	.39
38106.0	302.813 1	97.760 3	44.809 1	.24199 5	.29485 5	9.126181 2	.1E-5 1	7.331473	57	6	.39
38110.0	310.77 1	90.321 3	44.808 1	.24205 5	.79955 5	9.126175 2	.1E-5 1	7.330964	44	6	.27
38114.0	318.73 1	82.881 3	44.806 1	.24215 5	.30424 6	9.126177 2	-.1E-5 1	7.329988	40	6	.29
38118.0	326.663 5	75.447 2	44.808 1	.24206 3	.80906 2	9.126180 2	-.1E-5 2	7.330869	42	6	.39

Table 8

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 ALPHA EPSILON 1

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
PERIGEE IN EARTH SHADOW					
38030.	953.	19.5	122.0	117.4	-0.120E-07
PERIGEE IN SUNLIGHT					
38034.	952.	14.2	115.2	111.7	0.552E-07
38038.	953.	8.7	107.8	105.8	0.192E-07
38042.	952.	3.2	100.1	99.7	-0.720E-07
38046.	951.	-2.4	92.5	93.6	-0.432E-06
38050.	980.	-8.9	85.4	88.3	0.576E-06
38054.	946.	-13.5	78.0	81.7	-0.240E-07
38062.	962.	-24.1	66.5	71.4	-0.144E-06
38066.	960.	-28.9	62.4	66.9	0.480E-07
38070.	962.	-33.3	59.8	63.2	-0.480E-07
38074.	964.	-37.2	58.4	60.3	-0.240E-07
38078.	964.	-40.5	58.3	58.3	-0.480E-07
38082.	966.	-42.9	59.0	57.2	0.144E-07
38086.	965.	-44.4	60.2	56.7	-0.480E-07
38090.	966.	-44.8	61.4	56.7	-0.480E-07
38094.	965.	-44.1	62.3	56.7	-0.720E-07
38098.	963.	-42.4	62.5	56.2	0.240E-07
38102.	962.	-39.7	61.8	55.1	-0.720E-08
38106.	961.	-36.3	60.2	53.1	-0.240E-07
38110.	959.	-32.3	57.4	50.3	-0.240E-07
38114.	956.	-27.7	53.7	46.7	0.240E-07
38118.	956.	-22.8	49.1	42.5	0.240E-07

Satellite 1962 Beta Mu 1 (Anna 1B)

Beatrice Miller

I. SAO smoothed elements

The following elements are based on 360 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38044.0 \text{ MJD}$$

$$\omega = (72^\circ 14 \pm 3) + (2959 \pm 4)t + 5^\circ 5879 \cos \omega$$

$$\Omega = (141^\circ 2832 \pm 5) - (3^\circ 60898 \pm 6)t + .0010 \cos \omega$$

$$i = (50^\circ 1411 \pm 5) - .0003 \sin \omega$$

$$e = (.007095 \pm 7) - (.22 \pm 68) \times 10^{-6}t + .0007539 \sin \omega$$

$$M = (.19630 \pm 8) + (13.34494 \pm 1)t + (.31 \pm 2) \times 10^{-6}t^2 - (.27 \pm 1) \\ \times 10^{-7}t^3 - .014249 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.25$.

The following elements are based on 207 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38074.0 \text{ MJD}$$

$$\omega = (160^\circ 63 \pm 5) + (2936 \pm 6)t + 5^\circ 5879 \cos \omega$$

$$\Omega = (33^\circ 0169 \pm 7) - (3^\circ 60892 \pm 7)t + .0010 \cos \omega$$

$$i = (50^\circ 1446 \pm 6) - .0003 \sin \omega$$

$$e = (.007095 \pm 8) - (.49 \pm 77) \times 10^{-6}t + .0007539 \sin \omega$$

$$M = (.5449 \pm 2) + (13.34496 \pm 2)t - (.142 \pm 2) \times 10^{-5}t^2 - (.11 \pm 2) \\ \times 10^{-7}t^3 - .014249 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.18$.

The following elements are based on 269 observations and are valid for the period March 1 through April 1, 1963.

$$T_o = 38102.0 \text{ MJD}$$

$$\omega = (243^\circ 43 \pm 7) + (3^\circ 027 \pm 6)t + 5^\circ 5879 \cos \omega$$

$$\Omega = (291^\circ 9672 \pm 7) - (3^\circ 60927 \pm 6)t + .0010 \cos \Omega$$

$$i = (50^\circ 1414 \pm 5) - .0003 \sin \omega$$

$$e = (.007030 \pm 5) - (.65 \pm 52) \times 10^{-6}t + .0007539 \sin \omega$$

$$M = (.2009 \pm 2) + (13.34463 \pm 2)t - (.66 \pm 2) \times 10^{-6}t^2 + (.31 \pm 2) \\ \times 10^{-7}t^3 - .014249 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1^\circ 30.$

II. SAO mean elements - Satellite 1962 Beta Mu 1

1 January - 30 March 1963

T (MJD)	ω	Ω	i	e	M	n	$n'/2$	q	N	D	σ
38030.0	35.5 1	191.813 2	50.139 2	.00753 2	*3551 4	13.345079 2	-•1E-5 9	7.451178	50	4	.49
38034.0	46.72 9	177.377 2	50.138 1	.00762 2	*7363 3	13.345092 2	*4E-5 2	7.450472	70	4	.53
38038.0	57.5 1	162.937 2	50.140 2	.00766 3	*1188 3	13.345099 3	*3E-5 3	7.450195	34	4	.55
38042.0	68.5 1	148.500 3	50.140 2	.00779 4	.5007 4	13.345103 5	*7E-5 4	7.449175	22	4	.53
38046.0	79.1 1	134.063 2	50.140 1	*00776 3	.8835 3	13.345105 3	*3E-5 3	7.449404	42	4	.61
38050.0	90.2 1	119.628 2	50.141 2	.00784 3	*2651 3	13.345104 4	-•6E-5 4	7.448796	53	4	.76
38054.0	100.49 7	105.195 1	50.143 1	*00782 2	*6489 2	13.345104 2	-•1E-5 9	7.448942	84	4	.52
38058.0	111.7 2	90.758 2	50.138 2	*00783 3	*0300 5	13.345094 3	*3E-5 3	7.448928	36	4	.53
38062.0	122.1 1	76.324 2	50.142 2	.00770 2	*4135 4	13.345092 2	-•3E-5 2	7.449846	29	4	.46
38066.0	133.0 2	61.880 3	50.150 3	.00757 3	*7958 5	13.345082 3	-•4E-5 3	7.450846	26	4	.59
38070.0	144.3 2	47.452 1	50.146 2	*00754 3	*1766 4	13.345077 3	*4E-5 2	7.451066	18	4	.41
38074.0	154.4 2	33.012 2	50.132 2	*00726 2	*5619 5	13.345070 5	-•7E-5 4	7.453203	34	4	.63
38078.0	166.4 2	18.580 3	50.142 2	*00722 2	*9400 6	13.345053 3	-•2E-5 3	7.453530	22	4	.45
38082.0	178.6 2	4.143 2	50.145 2	*00705 2	*3185 5	13.345039 3	-•2E-5 3	7.454759	32	4	.54
38086.0	190.5 2	349.709 1	50.145 1	*00687 1	*6980 4	13.345026 3	-•5E-5 2	7.456164	45	4	.48
38090.0	202.6 2	335.274 2	50.144 2	*00673 1	*0767 6	13.345009 2	-•6E-5 2	7.457154	50	4	.61
38094.0	214.7 2	320.838 3	50.143 2	*00654 3	*4554 7	13.345002 4	*4E-5 4	7.458606	24	4	.51
38098.0	227.2 2	306.401 2	50.147 2	*00644 2	*8329 6	13.345001 2	*2E-5 3	7.459393	11	4	.27
38102.0	240.2 2	291.971 2	50.144 2	*00634 1	*2092 5	13.344980 2	-•4E-5 2	7.460152	39	4	.50
38106.0	253.7 6	277.529 3	50.145 4	*00631 2	*548 2	13.344983 7	-•4E-5 6	7.460350	26	4	.82
38110.0	267.4 2	263.094 1	50.139 1	*006261 9	*9586 7	13.344973 2	*6E-5 2	7.460721	47	4	.52
38114.0	281.0 2	248.655 2	50.143 2	*00629 1	*3333 5	13.344983 3	*4E-5 2	7.460497	36	4	.52
38118.0	293.8 2	234.218 2	50.141 1	*00632 2	*7100 4	13.344977 2	*4E-5 2	7.460275	51	4	.55

Table 9

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA MU 1

MJD	Z	Φ	Ψ	D.R.A.	P
PERIGEE IN SUNLIGHT					
38030.	1077.	26.5	79.5	295.7	0.112E-07
38034.	1079.	34.0	89.9	286.5	-0.449E-07
38038.	1081.	40.3	98.0	278.6	-0.337E-07
38042.	1082.	45.6	103.2	273.1	-0.786E-07
38046.	1083.	48.9	106.1	269.2	-0.337E-07
38050.	1083.	50.1	106.9	267.5	0.674E-07
38054.	1083.	49.0	107.8	264.7	0.112E-07
38058.	1081.	45.5	108.5	261.8	-0.337E-07
38062.	1081.	40.6	111.6	255.8	0.337E-07
38066.	1079.	34.2	116.5	248.4	0.449E-07
PERIGEE IN EARTH SHADOW					
38070.	1077.	26.6	123.3	239.8	-0.449E-07
38074.	1078.	20.2	133.4	228.3	0.157E-06
38078.	1076.	10.4	141.7	219.0	0.225E-07
38082.	1076.	1.1	150.0	208.6	0.225E-07
38086.	1078.	-8.0	155.2	198.1	0.562E-07
38090.	1081.	-17.2	154.0	188.0	0.674E-07
38094.	1084.	-25.9	148.0	178.9	-0.449E-07
38098.	1088.	-34.3	140.4	171.5	-0.225E-07
38102.	1091.	-41.8	133.8	166.9	0.449E-07
38106.	1094.	-47.5	129.7	166.0	0.449E-07
38110.	1095.	-50.1	129.2	168.4	-0.674E-07
38114.	1094.	-48.9	132.3	171.3	-0.449E-07
38118.	1092.	-44.6	138.0	170.9	-0.449E-07

Satellite 1962 Beta Tau 2 (Injun III)

Beatrice Miller

I. SAO smoothed elements

The following elements are based on 75 observations and are valid for the period January 16 through February 1, 1963.

$$T_o = 38054.0 \text{ MJD}$$

$$\omega = (102^\circ 86 \pm 6) - (1^\circ 088 \pm 8)t - .38 \times 10^{-4}t^2 + .2278 \cos \omega$$

$$\Omega = (145^\circ 288 \pm 6) - (1^\circ 6799 \pm 4)t - .98 \times 10^{-4}t^2 + .0332 \cos \omega$$

$$i = (70^\circ 367 \pm 8) - .0024 \sin \omega$$

$$e = (.1601 \pm 2) - (.22 \pm 28) \times 10^{-4}t - .267 \times 10^{-6}t^2 + .0007049 \sin \omega$$

$$M = (.7808 \pm 2) + (12.40816 \pm 4)t + (.0002173 \pm 7)t^2 - (.121 \pm 5) \times 10^{-5}t^3 \\ + (.29 \pm 1) \times 10^{-6}t^4 - .0006099 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.50$.

The following elements are based on 90 observations and are valid for the period February 1 through February 15, 1963.

$$T_o = 38068.0 \text{ MJD}$$

$$\omega = (87^\circ 487 \pm 9) - (1^\circ 094 \pm 2)t - .38 \times 10^{-4}t^2 + .2278 \cos \omega$$

$$\Omega = (121^\circ 7493 \pm 4) - (1^\circ 68280 \pm 8)t - .98 \times 10^{-4}t^2 + .0332 \cos \omega$$

$$i = (70^\circ 3675 \pm 6) - .0024 \sin \omega$$

$$e = (.159932 \pm 8) - (.33 \pm 2) \times 10^{-4}t - .267 \times 10^{-6}t^2 + .0007049 \sin \omega$$

$$M = (.54294 \pm 3) + (12.414860 \pm 6)t + (.0002257 \pm 6)t^2 + (.399 \pm 6) \times 10^{-5}t^3 \\ + (.51 \pm 13) \times 10^{-7}t^4 - .0006099 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.35$.

The following elements are based on 57 observations and are valid for the period February 15 through March 1, 1963.

$$T_o = 38082.0 \text{ MJD}$$

$$\omega = (72^\circ 138 \pm 7) - (1^\circ 095 \pm 1)t - 38 \times 10^{-4}t^2 + 2278 \cos \omega$$

$$\Omega = (98^\circ 178 \pm 1) - (1^\circ 6842 \pm 2)t - 98 \times 10^{-4}t^2 + 0332 \cos \omega$$

$$i = (70^\circ 366 \pm 2) - 0024 \sin \omega$$

$$e = (.15972 \pm 1) - (.16 \pm 3) \times 10^{-4}t - .267 \times 10^{-6}t^2 + .0007049 \sin \omega$$

$$M = (.40061 \pm 3) + (12.421759 \pm 4)t + (.000248 \pm 1)t^2 + (.190 \pm 5) \times 10^{-5}t^3 \\ - (.88 \pm 18) \times 10^{-7}t^4 - .0006099 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.46$.

The following elements are based on 80 observations and are valid for the period March 1 through March 16, 1963.

$$T_o = 38096.0 \text{ MJD}$$

$$\omega = (56^\circ 827 \pm 7) - (1^\circ 095 \pm 1)t - 38 \times 10^{-4}t^2 + 2278 \cos \omega$$

$$\Omega = (74^\circ 579 \pm 1) - (1^\circ 6869 \pm 4)t - 98 \times 10^{-4}t^2 + 0332 \cos \omega$$

$$i = (70^\circ 365 \pm 1) - 0024 \sin \omega$$

$$e = (.15927 \pm 2) - (.33 \pm 7) \times 10^{-4}t - .267 \times 10^{-6}t^2 + .0007049 \sin \omega$$

$$M = (.35809 \pm 2) + (12.429782 \pm 4)t + (.0003941 \pm 4)t^2 + (.711 \pm 7) \times 10^{-5}t^3 \\ - (.694 \pm 8) \times 10^{-6}t^4 - .0006099 \cos \omega$$

Standard error of one observation: $\sigma = \pm 4.23$.

The following elements are based on 183 observations and are valid for the period March 16 through April 1, 1963.

$$T_o = 38112.0 \text{ MJD}$$

$$\omega = (39^\circ 269 \pm 6) - (1^\circ 099 \pm 1)t - 38 \times 10^{-4}t^2 + 2278 \cos \omega$$

$$\Omega = (47^\circ 5615 \pm 9) - (1^\circ 6906 \pm 2)t - 98 \times 10^{-4}t^2 + 0332 \cos \omega$$

$$i = (70^\circ 365 \pm 1) - 0024 \sin \omega$$

$$e = (.15883 \pm 2) - (.32 \pm 4) \times 10^{-4}t - .267 \times 10^{-6}t^2 + .0007049 \sin \omega$$

$$M = (.33697 \pm 2) + (12.442907 \pm 4)t + (.0004696 \pm 4)t^2 + (.177 \pm 2) \times 10^{-5}t^3 \\ - (.121 \pm 6) \times 10^{-6}t^4 - .0006099 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.82$.

II. SAO mean elements - Satellite 1962 Beta Tau 2

18 January - 28 February 1963

T (MJD)	ω	Q	i	e	M	n	$n'/2$	q	N	D	σ
38048.0	109•281 4	155•3593 5	70•3593 7	•161109 7	•34067 1	12•405144 2	•297E-3 1	6•613483	57	6	•45
38050.0	107•108 4	152•0043 6	70•3582 9	•16118 2	•15213 2	12•406276 2	•274E-3 2	6•612504	47	6	•57
38052.0	104•941 7	148•043 3	70•362 4	•16097 2	•96567 2	12•40726 2	•241E-3 1	6•613800	27	6	•47
38054.0	102•75 1	145•287 4	70•360 5	•16093 3	•78123 4	12•408194 4	•225E-3 2	6•613837	24	6	•54
38056.0	100•56 1	141•926 4	70•363 4	•16091 2	•59856 3	12•409049 3	•195E-3 3	6•613693	27	6	•49
38058.0	98•38 2	138•57 1	70•35 1	•16098 6	•41743 5	12•409860 7	•215E-3 4	6•612797	26	6	•94
38060.0	96•26 2	135•201 4	70•366 5	•16095 4	•23777 5	12•410941 4	•343E-3 3	6•612708	40	6	•82
38062.0	93•99 2	131•0387 4	70•3652 7	•16081 1	•06142 6	12•412351 4	•227E-3 2	6•613288	44	6	•66
38064.0	91•79 2	128•4785 5	70•3648 7	•160727 7	•88708 5	12•413216 3	•211E-3 1	6•613627	55	6	•74
38066.0	89•67 1	125•1176 3	70•3642 5	•160736 7	•71414 3	12•414019 2	•1967E-3 7	6•613277	39	6	•47
38068.0	87•48 1	121•747 1	70•364 3	•16067 2	•54302 3	12•414829 3	•208E-3 2	6•613519	29	6	•56
38070.0	85•27 1	118•3822 7	70•362 3	•16073 2	•37358 3	12•415752 5	•290E-3 2	6•612730	29	6	•67
38072.0	83•09 1	115•0196 6	70•364 2	•16064 2	•20623 3	12•416920 2	•294E-3 2	6•612997	42	6	•62
38074.0	80•922 8	111•6546 5	70•363 2	•16055 1	•04122 2	12•41804'3	•256E-3 2	6•613295	49	6	•55
38076.0	78•753 9	108•287 1	70•365 2	•16051 2	•87833 3	12•419012 2	•228E-3 1	6•613253	47	6	•63
38078.0	76•581 8	104•9201 9	70•362 2	•16047 2	•71725 2	12•419888 2	•212E-3 1	6•613309	36	6	•49
38080.0	74•40 1	101•557 3	70•361 3	•16040 3	•55787 4	12•420748 6	•218E-3 3	6•613557	20	6	•54
38082.0	72•20 2	98•194 2	70•367 3	•16041 5	•40039 6	12•421751 6	•261E-3 3	6•613112	15	6	•62
38084.0	70•02 2	94•823 2	70•366 4	•16040 4	•24493 4	12•422787 8	•256E-3 6	6•612783	14	6	•66
38086.0	67•84 1	91•452 2	70•365 2	•16035 3	•9151 3	12•423813 6	•255E-3 4	6•612811	15	6	•56
38088.0	65•670 9	88•079 2	70•368 2	•16024 2	•94012 2	12•424863 2	•268E-3 1	6•613376	19	6	•46

T (MJD)	ω	Ω	i	e	M	n	$n'/2$	q	N	D	σ
38090.0	63.47 1	84.713 2	70.365 2	*16026 2	*79095 2	12.0125989 2	*297E-3 2	6.61274 1	17 6	*47	
38092.0	61.30 1	81.342 3	70.375 2	*16015 2	*64408 2	12.0427198 2	*306E-3 1	6.613211	22 6	*53	
38094.0	59.142 5	77.974 1	70.374 1	*16010 1	*49961 1	12.0428441 2	*323E-3 1	6.613201	28 6	*49	
38096.0	56.900 8	74.596 1	70.365 2	*15988 2	*35791 2	12.049811 3	*384E-3 2	6.614407	32 6	*86	
38098.0	54.809 6	71.2225 9	70.362 1	*16005 2	*21874 1	12.0431406 2	*4247E-3 9	6.612518	36 6	*54	
38100.0	52.611 9	67.847 2	70.366 3	*15985 6	*08331 3	12.0433096 1	*423E-3 1	6.613489	30 6	*61	
38102.0	50.408 9	64.0474 3	70.365 3	*15963 6	*95118 3	12.0434616 3	*368E-3 1	6.614655	45 6	*71	
38104.0	48.205 6	61.101 1	70.364 2	*15958 4	*82194 2	12.0436064 1	*3552E-3 9	6.614527	50 6	*47	
38106.0	46.004 1	57.725 2	70.360 3	*15953 5	*69541 4	12.0437574 3	*397E-3 2	6.614382	61 6	*73	
38108.0	43.837 9	54.0348 2	70.361 2	*15948 4	*57219 3	12.0439277 3	*448E-3 1	6.614182	58 6	*47	
38110.0	41.65 2	50.970 2	70.369 4	*15946 5	*45255 8	12.0441059 3	*440E-3 2	6.613716	49 6	*48	
38112.0	39.42 1	47.588 2	70.365 2	*15934 5	*33656 6	12.0442884 3	*473E-3 2	6.614042	47 6	*53	
38114.0	37.232 9	44.208 1	70.366 1	*15917 3	*22425 3	12.0444793 2	*482E-3 1	6.614681	55 6	*44	
38116.0	35.047 8	40.826 1	70.366 2	*15905 3	*11576 3	12.0446702 2	*472E-3 1	6.614941	67 6	*45	
38118.0	32.884 9	37.444 2	70.367 3	*15899 3	*01097 3	12.0448599 2	*474E-3 1	6.614748	82 6	*45	

Table 10

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA TAU 2

MJD	Z	Φ	Ψ	D.R.A.	P
PERIGEE IN SUNLIGHT					
38048.	252.	62.7	83.6	351.2	-0.386E-05
38050.	252.	64.2	85.4	342.1	-0.356E-05
38052.	253.	65.5	87.7	332.6	-0.313E-05
38054.	254.	66.7	90.3	322.6	-0.292E-05
38056.	254.	67.8	93.2	312.2	-0.253E-05
38058.	253.	68.7	96.4	301.4	-0.279E-05
38060.	253.	69.4	99.6	290.4	-0.445E-05
38062.	254.	70.0	103.1	278.7	-0.295E-05
PERIGEE IN EARTH SHADOW					
38064.	254.	70.3	106.6	266.9	-0.274E-05
38066.	254.	70.4	109.9	255.2	-0.255E-05
38068.	254.	70.2	113.2	243.3	-0.270E-05
38070.	253.	69.8	116.4	231.6	-0.376E-05
38072.	253.	69.2	119.3	220.3	-0.381E-05
38074.	253.	68.4	121.7	209.3	-0.332E-05
38076.	253.	67.5	123.8	198.8	-0.296E-05
38078.	253.	66.4	125.3	188.8	-0.275E-05
38080.	253.	65.1	126.1	179.1	-0.283E-05
38082.	252.	63.7	126.3	169.9	-0.338E-05
38084.	251.	62.3	125.8	161.0	-0.332E-05
38086.	251.	60.7	124.5	152.6	-0.330E-05
38088.	251.	59.1	122.5	144.4	-0.347E-05
38090.	250.	57.4	119.9	136.5	-0.385E-05

Table 10 (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA TAU 2

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
38092.	249.	55.7	116.6	128.8	-0.396E-05
38094.	249.	54.0	112.9	121.4	-0.418E-05
38096.	249.	52.1	108.8	114.1	-0.497E-05
PERIGEE IN SUNLIGHT					
38098.	247.	50.3	104.3	107.1	-0.550E-05
38100.	247.	48.4	99.5	100.1	-0.547E-05
38102.	248.	46.5	94.4	93.3	-0.476E-05
38104.	247.	44.6	89.0	86.6	-0.459E-05
38106.	246.	42.7	83.6	80.0	-0.513E-05
38108.	245.	40.7	77.9	73.4	-0.579E-05
38110.	244.	38.8	72.1	67.0	-0.569E-05
38112.	243.	36.7	66.2	60.6	-0.611E-05
38114.	243.	34.7	60.1	54.3	-0.622E-05
38116.	243.	32.7	54.1	48.0	-0.609E-05
38118.	242.	30.8	48.0	41.8	-0.612E-05

Satellite 1962 Beta Upsilon 1 (Relay I)

Beatrice Miller

I. SAO smoothed elements

The following elements are based on 62 observations and are valid for the period December 15, 1962 through January 1, 1963.

$$T_o = 38022.0 \text{ MJD}$$

$$\omega = (189^\circ 659 \pm 5) + (1^\circ 2120 \pm 7)t + .0961 \cos \omega$$

$$\Omega = (205^\circ 793 \pm 2) - (1^\circ 2789 \pm 4)t + .0158 \cos \omega$$

$$i = (47^\circ 502 \pm 1) - .0082 \sin \omega$$

$$e = (.28428 \pm 2) - (.19 \pm 25) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.865569 \pm 8) + (7.780944 \pm 1)t + (.48 \pm 9) \times 10^{-6}t^2 - .0002586 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.61$.

The following elements are based on 207 observations and are valid for the period January 1 through February 1, 1963.

$$T_o = 38046.0 \text{ MJD}$$

$$\omega = (218^\circ 7786 \pm 5) + (1^\circ 21148 \pm 9)t + .0961 \cos \omega$$

$$\Omega = (175^\circ 0858 \pm 2) - (1^\circ 27828 \pm 3)t + .0158 \cos \omega$$

$$i = (47^\circ 5030 \pm 2) - .0082 \sin \omega$$

$$e = (.284399 \pm 2) + (.65 \pm 3) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.608269 \pm 1) + (7.7809470 \pm 2)t - (71 \pm 11) \times 10^{-7}t^2 + (.60 \pm 11) \\ \times 10^{-8}t^3 - .0002586 \cos \omega$$

Standard error of one observation: $\sigma = \pm 2.45$.

The following elements are based on 260 observations and are valid for the period February 1 through March 1, 1963.

$$T_o = 38074.0 \text{ MJD}$$

$$\omega = (25297146 \pm 9) + (1^\circ 2128 \pm 1)t + .0961 \cos \omega$$

$$\Omega = (139^\circ 2765 \pm 7) - (1^\circ 27944 \pm 9)t + .0158 \cos \omega$$

$$i = (47^\circ 5135 \pm 3) - .0082 \sin \omega$$

$$e = (.284619 \pm 4) + (.12 \pm 6) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.474925 \pm 3) + (7.7809604 \pm 3)t + (.12 \pm 1) \times 10^{-6}t^2 - .0002586 \cos \omega$$

Standard error of one observation: $\sigma = \pm 3.13$.

The following elements are based on 181 observations and are valid for the period March 1 through April 1, 1963.

$$T_o = 38104.0 \text{ MJD}$$

$$\omega = (289^\circ 1000 \pm 3) + (1^\circ 21129 \pm 2)t + .0961 \cos \omega$$

$$\Omega = (100^\circ 85127 \pm 6) - (1^\circ 279947 \pm 6)t + .0158 \cos \omega$$

$$i = (47^\circ 50484 \pm 4) - .0082 \sin \omega$$

$$e = (.284935 \pm 1) + (.48 \pm 1) \times 10^{-5}t + .0005025 \sin \omega$$

$$M = (.9041128 \pm 5) + (7.78098333 \pm 5)t + (.86 \pm 3) \times 10^{-7}t^2 - .0002586 \cos \omega$$

Standard error of one observation: $\sigma = \pm 1.80$.

II. SAO mean elements - Satellite 1962 Beta Upsilon 1

20 December 1962 - 30 March 1963

T (MD)	ω	Ω	i	e	M	n	n'/2	q	N	D	σ
38018.0	184.732 5	210.897 4	47.507 3	.28420 3	.74203 1	7.780941 2	.5E-6 8	7.700094	20	6	.42
38022.0	189.45 6	205.78 1	47.52 2	.2843 2	.86606 8	7.78100 2	-.3E-4 1	7.699852	8	6	.98
38026.0	194.40 1	200.664 6	47.497 5	.28410 7	.98954 2	7.780960 6	-.4E-5 3	7.701112	16	6	.53
38030.0	199.221 3	195.5341 6	47.5008 4	.284204 8	.113561 7	7.780968 2	-.42E-5 8	7.699974	38	6	.36
38034.0	204.131 2	190.4240 7	47.5022 3	.284100 7	.237152 3	7.780946 1	-.30E-5 9	7.701109	52	6	.31
38038.0	208.952 2	185.319 1	47.5023 4	.284084 6	.361068 7	7.7809306 9	-.122E-4 8	7.701293	29	6	.26
38042.0	213.8686 6	180.1878 3	47.5035 2	.284035 1	.484680 1	7.7809541 3	-.148E-4 3	7.701809	57	6	.27
38046.0	218.7075 5	175.0696 4	47.5059 1	.284075 2	.608463 1	7.7809487 3	-.12E-5 2	7.701379	66	6	.16
38050.0	223.567 1	169.9629 2	47.5077 2	.284062 2	.732206 2	7.780943 2	-.15E-5 6	7.701520	53	6	.20
38054.0	228.416 3	164.833 2	47.5054 5	.28400 1	.856050 7	7.780955 2	-.60E-5 9	7.702219	31	6	.35
38058.0	233.257 4	159.727 2	47.5124 5	.28409 1	.97918 9	7.780954 2	-.7E-5 1	7.701181	34	6	.43
38062.0	238.128 1	154.607 1	47.5135 7	.284161 7	.103566 2	7.780939 1	-.6E-6 8	7.700456	58	6	.37
38066.0	242.9756 9	149.4900 5	47.5132 3	.284224 3	.227362 3	7.7809565 6	.5E-6 3	7.699775	80	6	.35
38070.0	247.8459 8	144.4002 4	47.5195 2	.284186 3	.351066 3	7.7809596 6	.82E-5 4	7.700175	54	6	.24
38074.0	252.698 4	139.278 2	47.525 1	.28422 5	.47492 2	7.780956 4	-.1E-7 2	7.699858	50	6	.71
38078.0	257.565 4	134.130 2	47.517 2	.28429 4	.59876 1	7.780960 5	.2E-6 9	7.699020	50	6	.43
38082.0	262.418 4	129.013 3	47.518 2	.28432 5	.72262 1	7.780958 7	-.1E-5 1	7.698690	51	6	.46
38086.0	267.280 2	123.906 2	47.5160 9	.28444 5	.84645 2	7.780980 4	-.8E-6 9	7.697470	50	6	.43
38090.0	272.1452 4	118.7722 1	47.5232 1	.284361 4	.970344 2	7.7809849 9	-.11E-5 5	7.698276	91	6	.36
38094.0	276.988 2	113.664 1	47.5130 9	.28441 1	.094254 5	7.780975 2	.18E-5 5	7.697739	52	6	.29
38098.0	281.832 2	108.5406 4	47.5121 3	.284439 4	.218207 3	7.780975 1	-.99E-5 8	7.697449	23	6	.23
38102.0	286.670 3	103.4210 4	47.5213 5	.28453 1	.342141 7	7.780997 2	-.54E-5 4	7.696404	7	6	.08
38106.0	291.535 5	98.299 1	47.5053 9	.28446 6	.46603 1	7.780977 7	.1E-5 5	7.697202	9	6	.39
38110.0	296.4005 5	93.17659 5	47.50984 4	.284509 2	.589929 1	7.7809816 2	-.19E-5 3	7.696684	35	6	.21
38114.0	301.2551 7	88.06283 8	47.51066 6	.28464 1	.713623 1	7.780979 2	.4E-6 4	7.695305	42	6	.35
38118.0	306.1270 9	82.9347 7	47.5163 2	.284632 6	.837709 3	7.7809824 9	.16E-5 3	7.695364	33	6	.16

Table 11

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA UPSILON 1

MJD	Z	ϕ	ψ	D.R.A.	\dot{P}
PERIGEE IN SUNLIGHT					
38018.	1322.	-3.5	121.5	126.7	-0.165E-07
38022.	1322.	-7.0	114.3	120.3	0.991E-06
38026.	1323.	-10.6	107.3	114.2	0.132E-06
38030.	1323.	-14.0	100.5	108.1	0.139E-06
38034.	1325.	-17.5	93.9	102.1	0.991E-07
38038.	1326.	-20.9	87.7	96.3	0.403E-06
38042.	1327.	-24.3	81.9	90.7	0.489E-06
38046.	1328.	-27.5	76.6	85.3	0.396E-07
38050.	1329.	-30.5	71.9	80.3	0.496E-07
38054.	1330.	-33.5	67.7	75.5	0.198E-06
38058.	1330.	-36.2	64.3	71.1	0.231E-06
38062.	1330.	-38.8	61.7	67.1	0.198E-07
38066.	1331.	-41.1	59.8	63.5	-0.165E-07
38070.	1332.	-43.1	58.5	60.4	-0.271E-06
38074.	1332.	-44.8	57.8	57.6	0.330E-09
38078.	1332.	-46.1	57.6	55.3	-0.661E-08
38082.	1332.	-47.0	57.7	53.2	0.330E-07
38086.	1331.	-47.4	57.9	51.5	0.264E-07

Table II (cont.)

RELATIVE POSITIONS OF THE SUN AND THE PERIGEE OF SATELLITE 1962 BETA UPSILON 1

MJD	Z	Ψ	ψ	D.R.A.	\dot{P}
38090.	1332.	-47.5	58.0	49.8	0.363E-07
38094.	1331.	-47.1	58.0	48.0	-0.595E-07
38098.	1330.	-46.2	57.7	46.2	0.327E-06
38102.	1329.	-45.0	57.1	44.0	0.178E-06
38106.	1329.	-43.3	56.0	41.6	-0.330E-07
38110.	1328.	-41.3	54.4	38.9	0.628E-07
38114.	1325.	-39.1	52.5	35.8	-0.132E-07